Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

aSB219.S93

SUGARBEET RESEARCH

1992 REPORT

FOREWARD

SUGARBEET RESEARCH is an annual compilation of progress reports concerning research by Agricultural Research Service investigators and cooperators who are engaged in sugar beet variety and production research. The report has been assembled and reproduced at the expense of the Beet Sugar Development Foundation, and is for the sole use of its members and the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. The report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor and the Beet Sugar Develepment Foundation.

The report presents results of investigations strengthened by contributions received under Cooperative Agreements between Agricultural Research Service, U.S. Department of Agriculture, and the Beet Sugar Development Foundation; the California Beet Growers Association; and the Sugarbeet Research and Education Board of Minnesota and North Dakota.

Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

CONTENTS

CONTENTS

CONTENTS

CONTENTS

PAGE

SECTION F -- IDAHO

SECTION G -- BUSHLAND, TEXAS

SUGARBEET RESEARCH

1992 Report

Section A

U.S. Agricultural Research Station, Salinas, California

Dr. J.E. Duffus, Plant Pathologist
Dr. L.L. Hoefert, Botanist
Dr. R.T. Lewellen, Geneticist
Dr. H.Y. Liu, Plant Pathologist
Dr. A.L. Pilgeram, Plant Pathologist
Dr. G.C. Wisler, Plant Pathologist
Dr. M.H. Yu, Geneticist
Dr. J.S. McFarlane, Collaborator

Cooperation:
Delta Sugar Company
Holly Sugar Company
Spreckels Sugar Division
California Beet Growers Association
California Industry Research Committee

The research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 210, 211, 212, 215, 203, and 260) and the California Beet Growers Association.

CONTENTS

CLARK, M.A., L. BAUMANN, M.A. MUNSON, P. BAUMANN, B.C. CAMPBELL, J.E. DUFFUS, L.S. OSBORNE, and N.A. MORAN. The eubacterial endosymbionts of whiteflies (Homoptera: Aleyrodoidea) constitute a lineage distinct from the endosymbionts of aphids and mealybugs. Cur. Microbiology 25:119-123. 1992.

Whiteflies (superfamily Aleyrodoidea) contain eubacterial endosymbionts localized within host cells known as mycetocytes. Sequence analysis of the genes for the 16S rRNA of the endosymbionts of *Bemisia tabaci, Siphoninum phillyreae*, and *Trialeurodes vaporariorum* indicates that these organisms are closely related and constitute a distinct lineage within the *y*-subdivision of the Proteobacteria. The endosymbionts of whiteflies are unrelated to the endosymbionts of aphids and mealybugs, which are in two separate lineages.

DUFFUS, J.E. Sweetpotato whitefly induced losses in USA - Plant interactions, viruses, and virus epidemiology. Proc. Nat'l. Lettuce Workshop, Monterey, CA, pg. 11. 1992.

The sweetpotato whitefly (*Bemisia tabaci)* and the viruses it transmits cause significant losses throughout the world. Recent decades have shown an increase in whitefly population densities and the occurrence of whitefly-borne viruses in the tropics and in wide areas of the subtropics, including areas of intensive agricultural production such as the southern United States and the Mediterranean region. The intensified losses have been attributed to the widespread use of synthetic organic insecticides, resistance to pesticides, enhancement by pesticides, changing climatic conditions, intensified agricultural practices, and the international transport of plant materials with contaminant populations of *Bemisia*.

During the fall of 1990, apparent changes in host preferences of *Bemisia* were noticed in California and isolations of the whiteflies were shown to be a mixture of two biotypes. The population prevalent in California since 1981 has been termed the cotton or "A" biotype and the new population has been termed the poinsettia or "B" biotype. The biotypes differ in a number of ways including their host preference, larval development, esterase banding patterns, and their abilities to induce silverleaf of squash and transmit viruses. Lettuce infectious yellows virus (LIYV) was transmitted 100 times less efficiently by the "B" biotype. Squash leaf curl virus (SLCV) was retained by "A" type whiteflies for 26 days as compared with only 14 days for the "B" biotype. Whiteflies of the "A" colony has a much higher frequency of transmission of SLCV and a higher initial transmission rate than the "B" biotype. Populations of the "B" biotype exploded in the southwest deserts during 1991 and reached populations 10x those previously recorded for the region.

The introduction of the new biotype into the southwest desert, coupled with its inefficiency to transmit important viruses, has significantly altered epidemiological characteristics of the whitefly transmitted viruses of the region. LIYV levels in desert sugarbeets and lettuce were less than 1.0% in 1991 in comparison to over 70% in 1990 and in previous seasons.

Preliminary crossing experiments between biotypes produced no detectable hybrids. However, whitefly populations of mixed biotypes maintained on different hosts shifted dramatically to one or the other biotype and segregates of recombination were present on all hosts.

Isozyme analysis of *Bemisia* from other areas indicates that these populations have the range of isozyme patterns representative of the variations or segregates of the "A" and "B" populations.

DUFFUS, J.E. Whitefly vectors: increasing threat to world agriculture. Proc. XIX Internat. Congr. Entomology, pg. 35. 1992.

The whitefly-transmitted viruses produce a wide and divergent group of diseases, most of which have not been characterized. The agents are transmitted by at least three whitefly species in the nonpersistent mechanisms. The viruses cause significant losses throughout the world and are responsible for some 70 important diseases in the tropical and subtropical areas. Recent years have shown an increase in losses in wide areas north and south of the tropics, approaching areas of intensive agricultural production. The whitefly-transmitted diseases have been characterized in general on the basis of their transmission by whiteflies and the activity of the agents on host plants, such as symptoms and host range. A compilation of available data on the viruses themselves would suggest at least seven groups of viruses differing in type of virus particle, symptom type, and vector relationships. These include geminiviruses, and viruses similar to the closteroviruses, caraviruses, potyviruses, nepoviruses, luteoviruses and a DNA-containing rod-shaped virus. Recent changes in importance and world distribution of *Bemisia* seems to be related to movement and displacement of biotypes or species.

DUFFUS, J.E. Whiteflies and whitefly-borne viruses an increasing threat to world agriculture. Proc. Internat. Working Group Legume Viruses (In Press). 1993.

Recent decades have shown an increase in whitefly population densities and the occurrence of whitefly-borne viruses in the tropics and in wide areas of the subtropics, approaching areas of intensive agricultural production such as the southern United States and the Mediterranean region. The whitefly-transmitted viruses produce a wide and divergent group of diseases, most of which have not been characterized. The agents are transmitted

by at least three whitefly species in the nonpersistent, semi-persistent, persistent, and by biological mechanisms. The viruses cause significant losses throughout the world and are responsible for some 70 important diseases in the tropical and subtropical areas. During the fall of 1990, changes in host preferences of *Bemisia* were noticed in California and isolations of the whiteflies were shown to be a mixture of two biotypes. The biotypes differ in a number of ways including their host preference, larval development, esterase banding patterns, and their abilities to induce silverleaf of squash and transmit viruses. Lettuce infectious yellows virus (LIYV) was transmitted 100 times less efficiently by the "B" biotype. Squash leaf curl virus (SLCV) was retained by "A" type whiteflies for 26 days as compared with only 14 days for the "B" biotype. Populations of the "B" biotype exploded in the southwest deserts during 1991 and reached populations 10x those previously recorded for the region. The introduction of the new biotype into the southwest desert, coupled with its inefficiency to transmit important viruses, has significantly altered epidemiological characteristics of the whitefly transmitted viruses of the region. LIYV levels in desert sugarbeets and lettuce were less than 1.0% in 1991 and 1992 in comparison to over 70% in 1990 and in previous seasons. Preliminary crossing experiments between biotypes produced no detectable hybrids. However, whitefly populations of mixed biotypes maintained on different hosts shifted dramatically to one or the other biotype and segregates or recombination were present on all hosts. Isozyme analysis of *Bemisia* from other areas indicates that these populations have the range of isozyme patterns representative of the variations or segregates of the "A" and "B" populations.

DUFFUS, J.E. and S. COHEN. Whitefly-borne viruses and their vectors in the sub-tropical environment. Proc. V. Internat. Plant Virus Epidemiology Symposium, pgs. 7-8. 1992.

Bemisia tabaci and the viruses it transmits cause significant losses throughout the world. Recent decades have shown an increase in whitefly population densities and the occurrence of whitefly-borne viruses in the tropics and in wide areas of the subtropics, approaching areas of intensive agricultural production such as the southern United States and the Mediterranean region. The intensified losses have been attributed to the wide spread use of synthetic organic insecticides, resistance to pesticides, enhancement by pesticides, changing climatic conditions, intensified agricultural practices, and the international transport of plant materials with contaminant populations of *Bemisia*.

B. tabaci was not a problem in California until 1981, when extremely large whitefly populations were associated with severe losses in lettuce, melons and sugarbeet. A whitefly-transmitted virus, lettuce infectious yellows virus (LIYV), reduced lettuce crops by 50% and sugarbeet crops by 30%. Losses of cucurbits were over $8 million in this one growing season.

B. tabaci in Florida was not an economic problem until 1986, when nurseries reported outbreaks on ornamentals. It has continued to be a problem because of its induction of feeding related diseases, such as silverleaf of squash, uneven ripening in tomatoes, and the transmission of geminiviruses. The whitefly has been increasing in incidence in Texas and has caused serious damage in that region as a vector of new geminiviruses. In addition to its roles as an inducer of feeding related diseases and a vector of plant viruses in agricultural environments, the sweetpotato whitefly is becoming a major factor in the nursery trade in protected environments throughout the world.

During the fall of 1990 apparent changes in host preferences of *Bemisia* were noticed and isolations of the whiteflies were shown to be a mixture of two biotypes. The population prevalent in California since 1981 has been termed the cotton or "A" biotype and the new population has been termed the poinsettia or "B" biotype. The biotypes differ in a number of ways including their ability to induce silverleaf of squash, host preference, larval development, by esterase isozyme banding patterns and transmission of viruses. LIYV was transmitted 100 times less efficiently by the "B" biotype. Squash leaf curl virus (SLCV) was retained by "A" type whiteflies for 26 days as compared with only 14 days for the "B" biotype. Whiteflies of the "A" colony had a much higher frequency of transmission of SLCV and a higher initial transmission rate than the "B" biotype.

Populations of the "B" biotype exploded in the southwest deserts during 1991 reaching populations 10 times those previously recorded for the region.

The combination of the elimination of melons (the major source of LIYV for fall vegetables) by direct whitefly feeding and the inefficiency of transmission of LIYV by the "B" biotype resulted in almost no LIYV infection in the desert. The demonstration of vector specificity between biotypes implies that this may occur in other areas of the world and that virus distribution may be dependent on the geographical distribution of whitefly biotypes.

DUFFUS, J.E., S. COHEN, and H.Y. LIU. The sweetpotato whitefly in western USA--biotypes, plant interactions, and virus epidemiology. Proc. 7th Conf. ISHS Working Group on Vegetable Viruses, pg. 76-77. 1992.

The sweetpotato whitefly has become increasingly more important in the United States since its outbreak occurrence in the southwest deserts in 1981. The whitefly caused economic losses to cotton by the contamination of the lint with honeydew and the transmission of the cotton leaf crumple virus. It has caused losses of more than 100 million dollars in vegetable production in the region in its role as a vector of lettuce infectious yellows virus and squash leaf curl virus. *Bemisia* has become an economic problem in Florida since 1986 because of its

induction of feeding related diseases, such as silverleaf of squash, uneven ripening in tomatoes, and the transmission of geminiviruses. The whitefly has been increasing in incidence in Texas and has caused serious damage in that region as a vector of a new geminivirus. In addition to its roles as an inducer of feeding related diseases and a vector of plant viruses in agricultural environments, the sweetpotato whitefly is becoming a major factor in the nursery trade in protected environments throughout the United States and the world.

During the fall of 1990 apparent changes in host preferences of *Bemisia* were noticed and isolations of the whiteflies were shown to be a mixture of two biotypes. The population prevalent in California since 1981 has been termed the cotton or "A" biotype and the new population has been termed the poinsettia or "B" biotype. The biotypes differ in a number of ways including their ability to induce silverleaf of squash, host preference, larval development, by esterase isozyme banding patterns and transmission of viruses. Lettuce infectious yellows virus (LIYV) was transmitted 100 times less efficiently by the "B" biotype. Squash leaf curl virus (SLCV) was retained by "A" type whiteflies for 26 days as compared with only 14 days for the "B" biotype. Whiteflies of the "A" colony had a much higher frequency of transmission of SLCV and a higher initial transmission rate than the "B" biotype.

Populations of the "B" biotype exploded in the southwest deserts during 1991 reaching populations 10 times those previously recorded for the region.

The introduction of the new biotype into the southwest desert, coupled with its inefficiency to transmit important viruses, has significantly altered epidemiological characteristics of the whitefly transmitted viruses of the region. LIYV levels in desert sugarbeets and lettuce were less than 1.0% in 1991 in comparison to over 70% in 1990 and in previous seasons.

The acquisition of SLCV antigen and detection in the body of the "B" biotype is higher than for the "A" biotype. However, the inoculation rate and retention of the virus is lower for the "B" whiteflies. This implies that the feeding mechanisms associated with acquisition probably are not factors in the decreased transmission rate, but that association of the virus with salivary secretions is reducing transmission.

The demonstration of vector specificity between biotypes implies that similar vector specificity may occur in other areas of the world and that virus distribution may be dependent on the geographical distribution of the whitefly biotypes.

DUFFUS, J.E., R.T. LEWELLEN, and H.Y. LIU. Implications of sweetpotato whitefly biotype changes on lettuce infectious yellows virus. J. Sugar Beet Res. (In Press). 1993.

Lettuce infectious yellows virus (LIYV) became a major disease

inducing agent of sugarbeet in the southwest desert region of U.S.A. during the 1980's. Losses as high as 20-30% were reported. The virus is vectored by the sweetpotato whitefly (*Bemisia tabaci*) in a semipersistent manner. During the Fall of 1990, changes in host preference of the whitefly were noticed in California and isolations of the whiteflies were shown to be a mixture of two biotypes. The population prevalent in California since 1981 has been termed the "A" biotype and the new population the "B" biotype. The biotypes differ in a number of ways including their host preference, larval development, esterase banding patterns, their abilities to induce systemic phytotoxemia and to transmit viruses. LIYV was transmitted 100 times less efficiently by the "B" biotype. Populations of the "B" biotype exploded in the southwest deserts during 1991 and 1992 and reached populations 10X those previously recorded for the region. The introduction of the new biotype into the southwest desert, the resulting host reactions, coupled with its inefficiency to transmit important viruses, has significantly altered epidemiological characteristics of the whitefly-transmitted viruses of the region. LIYV levels in desert crops were less than 1.0% in 1991 and 1992 in comparison to over 70% in 1990 and in the previous 10 years.

FOX, L., K.D. BEVIER, H.H. TOBA, J.E. DUFFUS, and P.E. THOMAS. Overwintering and monitoring of potato leafroll virus in some wild crucifers. American Potato Journal (In press). 1993.

A potato leafroll virus (PLRV) isolate has been successfully transmitted to and recovered from two wild crucifers, *Sisymbrium altissimum* L. (Jim Hill or tumble mustand) and *Capsella bursa-pastoris* (L.) Medic. (shepherd's purse) by the green peach aphid (GPA), *Myzus persicae* (Sulzer). Virus antigen in both plant species was found to be higher in root tissue than in foliar tissue based on enzyme-linked immunosorbent assay (ELISA) determinations. *C.bursa-pastoris* was apparently a relatively poorer source of inoculum for the GPA than *S.alissimum*. Using two geographically-separated biotypes of *C.bursa-pastoris*, a Washington biotype was found to contain higher antigen titer in both leaf and root tissue than a California biotype, as determined by ELISA. Field studies demonstrated that both weed species can serve as overwintering sources of PLRV.

LEWELLEN, R.T. and S.R. TEMPLE. Registration of C31-43 and C31-89 beet yellows virus-resistant germplasm of sugarbeet. Crop Sci. 32:1297. 1992.

C31-43 and C31-89 are sugarbeet germplasm lines released in 1991. C31-43 and C31-89 are sister lines descended from half-sib families from germplasm C31/6, an advanced reselection for performance and disease resistance from C31. They are multigerm, self-sterile, and segregate for hypocotyl color. Infield tests, both lines had good to moderate resistance to virus yellows caused by beet yellows virus (BYV) and beet

western yellows virus (BWYV), erwinia root rot and bolting. They were moderately susceptible to curly top virus (CTV) and intermediate in reaction to powdery mildew. In field tests, the lines gave high sugar yield, moderate sucrose concentration, and low soil tare, and the beets extended above the soil. These lines outyielded most commercial hybrids under BYV-infected conditions. As pollinators in experimental hybrid combinations, they showed good general combining ability for sugar yield. These hybrids were usually the best in the test for sugar yield under conditions where less resistant varieties were heavily infected with virus yellows. The hybrids showed midparent values for percent loss due to virus yellows.

LIU, H.Y. and J.E. DUFFUS. A new soil-borne virus from California. Sugar Beet Res. (In press). 1993.

A new soil-borne virus of sugarbeet has recently been found in the Imperial Valley of California. The infectious agent is mechanically transmissible. In limited host range studies, it mechanically affects five plant families. Most of these hosts show necrotic local esions. The virus has been purified from *Chenopodium quinoa*. The virions are isometric, and are approximately 25 nm in diameter. They contain a single species of single-stranded RNA of approximately 3.70 kilobases and a single capsid protein of approximately 31.0 kilodaltons. Purified virus was infective and had an A_{260}/A_{280} ratio of 1.66. An antiserum to the virus with a titer of 1/512 in immunodiffusion tests was prepared from purified preparations. The particle morphology, the protein coat subunits and nucleic acid size are similar to those of tobacco necrosis virus (TNV). However, no serological relationship to TNV has been demonstrated. The vector of this virus has not been found. The distribution of the virus in the field, the economic importance of the virus, and the relationship of this infectious agent to other soil-born diseases of sugarbeet are not yet known.

LIU, H.Y., J.E. DUFFUS and S. COHEN. Bemesia biotype alterations by hosts and intra-biotype mating. Bemisia Newsletter. 6:5-6. 1992.

Preliminary crossing experiments between the "A" and "B" biotypes of *Bemisia tabaci* from the California desert using virgin males and females in short breeding periods produced no detectable hybrids.

Limited analysis of field collected whiteflies from the desert region had indicated an almost complete shift in the population from the previously occurring "A" biotype to the newly introduced "B" biotype. The biotypes were known from previous work to differ in the suitability of various hosts for nymphal development. Thus it was of interest to determine in the laboratory how this shift in population took place. Equal numbers of males and females of both biotypes (25 A males and 25 A females, plus 25 B males and 25 B females) were enclosed in large muslin-covered cages.

An esterase isozyme analysis on polyacrylamide gels was made of the caged mixed population at approximately monthly intervals. Parent survivors and subsequent generation adults on most hosts were a mixture of the "A" and "B" biotypes. However, as there were a substantial number of hybrids or segregates, it is possible that a breakdown of apparent reproductive barriers occurred during the prolonged mixing experiments.

Populations maintained on sweetpotato and bean shifted quickly to the "A" biotype, whereas those maintained on broccoli and melon shifted to the "B" biotype. However, after five months, segregates or recombinations of the "A" and "B" biotypes as determined by isozyme patterns were present in all hosts.

An isozyme analysis of *Bemisia* from California ("A" and "B"), Florida, Texas, Nigeria and Israel indicates that these populations have the range of isozymes representative of the variations or segregates of the "A" and "B" populations. However, the Israeli population had additional bands not present in populations from the other regions.

Recent analysis of desert populations indicate a mixture of "A"s, "B"s and hybrids. Thus under the laboratory and natural field conditions these two populations do not remain distinct.

It seems that host suitability plays a major role in the adaptability of whitefly biotypes to different regions. Manipulating hosts and/or biotypes through breeding may be useful in changing the predominant whitefly in a region.

LIU, H.Y., J.E. DUFFUS, and S. COHEN. *Bemisia tabaci* population control by host manipulation and genetics. Proc. V. International Plant Virus Epidemiology Symposium. 227-228. 1992.

Recent collections of *Bemisia tabaci* from California and Arizona desert regions recovered a new biotype that virtually has replaced the previously known biotype. The new biotype population ("B") differs in several ways from the previously occurring population ("A"), including their ability to induce silverleaf of squash, host preference, larval development, isozyme banding patterns and virus transmission. Preliminary crossing experiments between the biotypes using virgin males and females in small leaf cages in a ratio of 1 female and 5 males produced no detectable hybrids. Other experiments involving larger cages (15 x 20 cm) with a ratio of 10 females and 100 males again produced no detectable hybrids.

Limited analysis of field collected whiteflies from the desert region had indicated on almost complete shift in the population from the previously occurring "A" biotype to the newly introduced "B" biotype. The biotypes were known from previous work to differ in the suitability of various hosts for nymphal development. Thus it was of interest to determine in the

laboratory how this shift in population took place. Equal numbers of males and females of both biotypes (25A males + 25A females + 25B males + 25B females) were enclosed in large muslin-covered cages.

An esterase isozyme analysis on polyacrylamide gels was made on the caged mixed population at approximately monthly intervals. Parent survivors and subsequent generation adults on most hosts were a mixture of the "A" and "B" biotypes, however, there were a substantial number of hybrids or segregates.

Populations maintained on sweetpotato and bean shifted quickly to the "A" biotype, whereas, those maintained on broccoli and melon shifted to the "B" biotype. After 5 months, segregates or recombinations of the "A" and "B" biotypes as determined by isozyme patterns were present on all hosts.

An isozyme analysis of *Bemisia* from California ("A" and "B"), Florida, Texas, Nigeria and Israel indicates that these populations have the range of isozymes representative of the variations or segregates of the "A" and "B" populations. However, the Israel population had additional bands not present in populations from the other regions. It seems that host suitability plays a major role in the adaptability of whitefly biotypes to different regions. Manipulating hosts and/or biotypes through breeding may be useful in changing the predominant whitefly in a region.

LIU, H.Y., J.E. DUFFUS, and S. COHEN. Isozyme patterns as a tool to monitor changes in *Bemisia* populations. Proc. 7th Conference of ISHS Working Group on Vegetable Viruses. 78-79. 1992.

Recent collections of *Bemisia tabaci* from California and Arizona desert regions recovered a new biotype that virtually has replaced the previously known biotype. The new biotype population "B" differs in several ways from the previously occurring population "A", including their ability to induce silverleaf of squash, host preference, larval development, virus transmission and isozyme banding patterns. The biotypes can not be distinguised morphologically. Within a biotype, esterase patterns of different developmental stages of eggs, pupae, and adults or sexes, collected on different hos plants were identical and only differ quantitatively. Whitefly colonies collected from poinsettia and hibiscus in various parts of California are identical in isozyme patterns to the Florida colony and to the "B" biotype. These all differ significantly in biology and isozyme patters from the "A" population.

The results of testing *B.tabaci* from the southwest desert for esterase banding patterns indicate that the population has shifted from the old population to the new biotype.

Preliminary crossing experiments between the biotypes produced no detectable hybrids. In an interest to determine the mechanisms of the population shifts in the desert colonies, equal numbers of males and females of both biotypes were enclosed in large cages on various hosts. Isozyme analysis was made on the caged mixed populations at approximately monthly intervals. Parent survivors and first generation adults on most hosts were a mixture of the "A" and "B" biotypes; however, there were a substantial number of hybrids or segregates.

Populations maintained on sweetpotato and bean shifted quickly to the "A" biotype, whereas, those maintained on broccoli and melon shifted to the "B" biotype. After 3 months, segregates or recombinations of the "A" and "B" biotypes as determined by isozyme patterns were present on all hosts.

An isozyme analysis of *Bemisia* from California ("A" and "B"), Florida, Texas, Nigeria and Israel indicates that these populations have the range of isozymes representative of the variations or segregates of the "A" and "B" populations. However, the Israel population had additional bands not present in populations from the other regions.

LIU, H.Y., J.E. DUFFUS, and S. COHEN. Intra-biotype mating with A and B biotypes of the sweetpotato whitefly. First Annual Review 5-year National Research and Action Plan - Sweetpotato Whitely. Proceeding. 42. 1993.

Preliminary crossing experiments between the "A" and "B" biotypes of *Bemisia tabaci* from the California desert using virgin males and females inshort breeding periods produced no detectable hybrids.

Limited analysis of field collected whiteflies from the desert region had indicated an almost complete shift in the population from the prebiously occuring "A" biotype to the newly introduced "B" biotype. The biotypes were known from previous work to differ in the suitability of various hosts in the laboratory how this shift in population took place. Equal numbers of males and females of both biotypes (25A males + 25A females + 25B males + 25B females) were enclosed in large muslin-covered cages.

An esterase isozyme analysis on polyacrylamide gels was made on the caged mixed population at approximately monthly intervals. Parent survivors and subsequent generation adults on most hosts were a mixture of the "A" and "B" biotypes, however, there were a substantial number of hybrids or segregates. Perhaps a breakdown of apparent reproductive barriers occurred during the prolonged mixing experiments.

Populations maintained on sweetpotato and bean shifted quickly to the "A" biotype, whereas, those maintained on broccoli and melon shifted to the "B" biotype. However, after 5 months, segregates or recombinations of the "A" and "B" biotypes as determined by isozyme patterns were present on all hosts.

An isozyme analysis of *Bemisia* from California ("A" and "B"), Florida, Texas, Nigeria and Israel indicates that these populations have the range of isozymes representative of the variations or segregates of the "A" and "B" populations. However, the Israel population had additional bands not present in populations from the other regions.

Recent analysis of desert populations indicate a mixture of "A"s and "B"s and hybrids. Thus under the laboratory and natural field conditions these two populations do not remain distinct. It seems that host suitability plays a major role in the adaptability of whitefly biotypes to different regions. Manipulating hosts and/or biotypes through breeding may be useful in changing the predominant whitefly in a region.

PILGERAM, A.L. and J.E. DUFFUS. Characcterization of single cystosori isolates of *Polymyxa betae.* International Working Group on Plant Viruses with Fungal Vectors. Montreal, Canada (In press). 1993.

Polymyxa betae, a ubiquitous soil fungus, is the vector of beet necrotic yellow vein virus. The genetic diversity of *Polymyxa* is being studied using RAPD analysis (Random Amplification of Polymorphic DNA). DNA is isolated from *Polymyxa* zoospores, individual cystosori, or infected root tissue and amplified with a Perkin-Elmer thermocycler using standard cycling parameters (94 C, 2 minutes: 35 C, 1 minute: 72 C, 1 minute). In preliminary studies, both similarities and differences in DNA banding patterns have been observed from *Polymyxa* populations from several western states as well as from individual cystosori isolated from a single infected beet root. Analysis of the genetic variation between species of *Polymyxa* and between aviruliferous and viruliferous isolates of *Polymyxa betae* is in progress.

PILGERAM, A.L. and J.E. DUFFUS. Characterization of single cystosori isolates of *Polymyxa betae.* Sugar Beet Res. (In press). 1993.

Polymyxa betae, a ubiquitous soil fungus, is the vector of beet necrotic yellow vein virus. The genetic diversity of *Polymyxa is being studied using RAPD analysis (Random Amplification of Polymorphic DNA). DNA is isolated from Polymyxa* zoospores, individual cystosori, or infected root tissue and amplified with a Perkin-Elmer thermocycler using standard cycling parameters (94 C, 2 minutes: 35 C, 1 minute: 72 C, 1 minute). In preliminary studies, both similarities and differences in DNA banding patterns have been observed from *Polymyxa* populations from several western states as well as from individual cystosori isolated from a single infected beet root. Analysis of the genetic variation between species of *Polymyxa* and between aviruliferous and viruliferous isolates of *Polymyxa betae* is in progress.

TEMPLE, S.R., R.T. LEWELLEN, and P.A. MAUK. Sugarbeet Pest Management Guidelines, Diseases. U.C. IPM PMG. 24:25-36. 1992.

Guidelines for sugarbeet disease management are given. These guidelines represent the best information currently available to the authors. The information should be useful to growers, fieldmen, etc. who make management decisions for integrated pest control.

WISLER, G.C., J.E. DUFFUS, and H.Y. LIU. Partial characterization of some furoviruses infecting sugarbeet. Sugar Beet Res. (In press). 1993.

Several soil-borne, rod-shaped virus isolates from sugarbeet from the U.S. were compared using antisera to structural and nonstructural proteins (courtesy H.Y. Liu and K. Richards) of beet necrotic yellow vein virus (BNYVV) by western blot analyses. Antisera to the C-terminal 1/3 of the BNYVV capsid protein was highly specific, reacting only to BNYVV isolates. Antisera to the whole capsid protein reacted with all BNYVV isolates, with a mw of ca. 22 kDa, and also cross-reacted with several other rod-shaped, soil-borne virus isolates of sugarbeet (Liu and Duffus, 1988), from Texas, Nebraska, and Idaho with a mw of ca. 23 kDa. Antisera to the 75 kDa and 14 kDa proteins were specific to BNYVV. In contrast, antisera to the 42 kDa protein reacted with all BNYVV isolates showing a mw of ca. 42 kDa, and also with the related sugarbeet isolates showing a mw of ca. 43 kDa. Antisera to the 25 kDa protein, which corresponds to RNA 3, reacted only with recently recovered isolates of BNYVV, but not with one which had been maintained by mechanical inoculation for several years. Thus, antisera to the C-terminus of the coat protein, the 75 kDa protein, and 14 kDa protein appear to be specific to BNYVV isolates, whereas the 42 kDa protein appears to be conserved among BNYVV and related furo-like virus isolates from Texas, Nebraska, and Idaho.

WISLER, G.C., J.E. DUFFUS, and H.Y. LIU. Variations among Furoviruses associated with sugarbeet. Internatinal Working Group on Plant Viruses with Fungal Vectors. Montreal, Canada. (In press). 1993.

Several soil-borne, rod-shaped virus isolates from sugarbeet from the U.S. were compared using antisera to structural and nonstructural proteins (courtesy H.Y. Liu and K. Richards) of beet necrotic yellow vein virus (BNYVV) by western blot analyses. Antisera to the C-terminal 1/3 of the BNYVV capsid protein was specific to BNYVV isolates. Antisera to the whole capsid protein reacted with all BNYVV isolates, and also cross-reacted with several other rod-shaped, soil-borne virus isolates of sugarbeet (Liu and Duffus, 1988). Antisera to the 75 kDa and 14 kDa proteins were specific to BNYVV. In contrast, antisera to the 42 kDa protein reacted with all BNTVV isolates and also with the related sugarbeet isolates. Antisera to the 25 kDa protein reacted with recently recovered isolates of BNYVV, but not with

one which had been maintained by mechanical inoculation for several years.

YOKOMI, R.K., D.R. JIMENEZ, J.P. SHAPIRO, J.E. DUFFUS, J.K BROWN, and J. BIRD. A new biotype of *Bemisia tabaci*: Interactions with plants and virus epidemiology. Proc. XIX International Congress of Entomology. 297. 1992.

A new *Bemisia tabaci* biotype identified as the "B strain," with unique biological and genetic properties, was first noted in Florida in 1986 and has spread rapidly throughout the sourthern U.S. and Caribbean Basin. Enormous infestations of the "B strain" in a variety of vegetable and fiber crops have resulted in plant virus epidemics and several new phytoxic disorders including squash silverleaf (SSL). Although the "B strain" contained specific double-stranded (ds) RNA bands, SSL could not be attributed to a plant virus. The indigenous "A strain" of *B. tabaci* induced attenuated to no SSL symptoms under test conditions and did not contain dsRNAs. SSL was characterized as a developmental phytotoxemia induced by whitefly feeding since removal of "B strain" whiteflies resulted in recovery from the disorder. Studies of vector/virus relationships conducted in independent laboratories suggests variability in efficiencies of transmission depending on the specific virus and possibly, in part, the host plant species. The concept of "race" or "biotype" of *B.tabaci* conceived in the 1960's (J.Bird) has received widespread attention in light of these recent occurrences.

YU, M.H. Increasing productivity through sustainable agriculture. In Republic of China Executive Yuan Council of Agriculture, ed. National Development Seminar Agricultural Division Monograph. Exec. Yuan Counc. Agric., Taipei, Taiwan. pp. 53-61. 1992.

Within four decades after World War II, farms in many developed countries became highly mechanized and specialized and heavily dependent on fossil fuels, chemical fertilizers and pesticides. Today the same farms are associated with declining soil productivity, deteriorating environmental quality, reduced profitability, and threats to human and animal health. The urgent needs for sustainable farming systems were thus seriously realized. Sustainable agriculture addresses multiple objectives, from reducing fertilizer, pesticide and other off-farm inputs, increasing farm profits and agricultural productivity, to conserving energy and natural resources, and may incorporate and build on multiple systems and practices, such as integrated pest management and crop rotations. The function and contribution of biotechnology to sustainable agriculture is still at infancy. Nonetheless, the preliminary results have demonstrated that an enhanced agricultural sustainability can be established through skillful coordination of qualified human resources and effective biotechnological manipulations. The importance of sustainable agriculture in the future is unrivaled for both ecological and economical reasons.

YU, M.H. Reproductivity of sugarbeet plants derived from ovules. 1st Intl. Crop Sci. Congr. Abstr. p. 68. 1992.

The phenotype and reproduction capability of sugarbeet ovule derivative plants were studied. With the used of modified MS culture medium, plantlets were induced from unpollinated ovules of several sugarbeet genotypes. Leaves characteristics of the majority of of plants were different from the donors and inferior to a varied degree in vigor, size and shape. More than 50% of the plants contained fewer than 10 chloroplasts in stomatal guard cells. Such phenomena implied the monoploidy in a majority of these plants. Based on root tip chromosome counts, approximately 60% of the plants were 18-chromosome. Pollinated by diploids, 26% of the plants did not produce viable seed. The results indicated that chromosome number of a gamete derived sugarbeet may not be represented by root tip chromosomes. With the probable high rates of monoploid shoots, over 70% of ovule derived sugarbeet, nevertheless, produced seed.

YU, M.H. Root-knot nematode and susceptibility of Beta plants to infection. ASSBT Abstr. (In press). 1993.

Meloidogyne spp. are plant parasites that cause root gall symptoms, and severely reduce sugarbeet yields and quality in many production regions. To learn root-knot nematode parasitism in sugarbeet, an investigation on root penetration, post-infection development, gall formation, and nematode reproductivity on specific hosts was conducted. Infection generally occurs at root tip area. After the second-stage juvenile (J2) has entered sugarbeet root it migrates and finds a suitable feeding site near the root vascular tissue in the endodermis. Nematode feeding stimulates formation of giant cells, hence root galls; meanwhile, juveniles undergo dimorphic development. The females reached the adult stage earlier than males. There was a positive association between levels of gall formation and nematode reproduction. Susceptibility of Beta plants to specific species/races of nematode varied noticeably by the number of root galls and eggs or JS reproduced. Among inoculated plants from Beta germplasm that generally formed 10 to >100 galls, accessions which segregated plants with no root galls and low M. incognita reproductivity also were identified.

YU, M.H. and J.E. DUFFUS. Differential reaction of Lycopersicon genotypes to infection of seven species/races of Meloidogyne juveniles. Tomato Genet. Coop. Rep. 42:46-47. 1992.

Seedling from five Lycopersicon genotypes (i.e., Tropic, 74T-3, LA 2398, LA 1610 and LA 1610B) were tested against seven races of nematode belonging to four Meloidogyne species (M. incognita races 1,3 and 4, M. arenaria races 1 and 2, M. javanica and M. hapla). Plants were grown in a greenhouse at 25 to 28^{o}C; root systems were examined 40 days after inoculations, the results indicated that line 74T-3 was susceptible to M. hapla, but was resistant to all M. incognita, M.javanic, and M. arenaria species

and races. In the latter three groups, 33.3% of the inoculated plants were free from gall formation and nematode reproductions. Thus, tomato line 74T-3 has carried either the Mi gene or a Mi-alike resistance factor(s) to these Meloidogyne species. The susceptibility of 74T-3 to M. hapla was similar to the rest of test plants inoculated with other nematodes.

Papers Published Since Abstracted in Previous Report

LEWELLEN, R.T. Use of plant introductions to improve populations and hybrids of sugarbeet. In Shands, H.L., and L.E. Weisner (eds). Use of Plant Introductions in Cultivar Development Part 2, CSSA Special Publication no. 20. p. 117-136. 1992.

DEVELOPMENT OF SUGARBEET BREEDING LINES AND GERMPLASM

R. T. Lewellen

BREEDING LINES C790-6, C790-15, and C790-54 - These monogerm, O-type, self-fertile lines were released in 1992. They were extracted as S_1 lines from population-790(C4) that had been improved by four cycles of S_1 progeny recurrent selection. The S_1 lines from population-790(C4) were tested at Brawley, CA under severe lettuce infectious yellows virus conditions and at Salinas under severe virus yellows conditions. The S_1 lines with the best performance were retested as components of topcross hybrids at Brawley and Salinas. From these tests, lines C790-6, C790-15, and C790-54 were identified, increased, and released. Based upon tests at Salinas, Brawley, and Davis in 1992, these lines have good general combining ability and adaptation. Of the three lines, C790-15 consistently had the best performance in 1992. These results are presented in this section of the report.

BREEDING LINE C859 - C859 is an increase from population-859. This line will segregate for most traits including monogermity, O-type, hypocotyl color, genetic male sterility, etc. C859 should be self-fertile. It will segregate for resistance to rhizomania (Rz). C859 was developed by backcrossing the Rz factor into C563/C566 type germplasm. C859 should be a useful source for developing monogerm, O-type lines that combine resistance to rhizomania, curly top, bolting, Fusarium stalk blight, and downey mildew.

NEMATODE RESISTANT LINES C603, C603-1, C604, C605, C606, C607 - These lines were released in 1992 as sources of resistance to cyst nematode. The nematode resistant line B883 was the source of resistance. Evidence to date suggests that C603, C603-1, and C604 are homozygous resistant and C605, C606, and C607 segregate for resistance. C603 and C603-1 are S_5 lines derived from a cross between a line similar to C17 and B883. C603 was advanced from one S_1 plant and has mixed red and green hypocotyls. C603-1 was derived from one S_3 plant and has green hypocotyl color. These lines are being tested under the experimental line designations N203, N103, N203-1, and N103-1. C604 thru C607 are S_4 lines derived from a cross between population-909 and B883. C604 is susceptible to rhizomania. C605, C606, and C607 may segregate for resistance to rhizomania. Hybrids involving C603 and C603-1 are presently being evaluated in field tests at Salinas and Brawley, CA.

REACTION TO ERWINIA - Lines and hybrids in the programs at Salinas were evaluated for reaction to Erwinia root rot in tests 2192 thru 2492. Five Erwinia isolates were used in the inoculum including a new isolate from Imperial Valley. In tests following field inoculation and infection, the Imperial Valley

isolate was found to be the most common and aggressive (Alice Pilgeram). C40 (E840) is the usual susceptible check in these tests and is highly susceptible. In addition, two hybrids with C40 were also used as checks in test 2192. They were E840H72 (= C718CMS x C40) and E840H8 (= C546H3 x C40). C718CMS is considered moderatly susceptible and C546H3 moderately resistant. Based upon the reaction of these hybrids and US H11 as a highly resistant check, C40 also could be used as a tester to determine resistance to Erwinia. This could be a useful way to evaluate inbred breeding lines. Because of low vigor, inbreds often appear to give readings for resistance that are false.

SELECTION FOR RESISTANCE TO RHIZOMANIA WITHIN LINES Y39 AND Y47- Phenotypic recurrent selection thru cycle 7 within Y39 (C39R) and Y47 (C47R) was evaluated (tests 2692-1 and RZM 492). Breeding lines Y39 and Y47 from the virus yellows resistance breeding program were identified as sources of quantitative (additive) resistance to rhizomania. Earlier tests had shown significant improvement in resistance to rhizomania by phenotypic recurrent selection. However, it appears that after cycle 4, relatively little additional improvement in resistance was achieved. This suggests that the genetic variability for resistance was exhausted after four cycles of selection and that only a few genes with high heritability are involved.

RESPONSE OF C39 TO PHENOTYPIC RECURRENT SELECTION FOR RHIZOMANIA RESISTANCE

		Sugar Yield (lbs/a)			
Variety	Cycle	Actual[1]	% change[1]	Actual[2]	% change[2]
US H11		4800		1400	
C39	CO	6800	0	3100	0
C39R4	C4	9400	39	4700	51
C39R5	C5	9500	39	4500	45
C39R6	C6	9700	42	5100	62
C39R7	C7	9700	43	5000	59
LSD (.05)		970	14	620	20

[1]Moderate rhizomania. pltd. 4/28; harv. 11/4.
[2]Mean 2 tests, pltd 6/5; harv. 11/16.

PERFORMANCE UNDER RHIZOMANIA CONDITIONS TO DETERMINE RESISTANCE- Because of the problems and difficulty to score individual roots for reaction to rhizomania, it has been my judgement that sugar yield relative to known resistant and susceptible checks is an easier and more accurate method to score varieties for resistance to rhizomania. The intent of yield evaluations at Salinas under rhizomania conditions is not to determine performance per se but to use performance in a broad sense to evaluate disease reaction categories. Under moderate to severe conditions, the effects of rhizomania are so overwhelming that entries fall into groupings based upon resistance levels.

This usually happens whether varieties have adaptation to Salinas or not, have other disease resistances or not, and are hybrids or lines. As the following table shows, an adapted but susceptible hybrid like US H11 is clearly distinguished from any of the three moderately resistant checks. This has also consistently been the pattern for near-isogenic lines. Sugar yield clearly differentiates the resistant version from the susceptible version. Obviously, if a variety has more subtle differences in resistance than that conditioned for example by the Rz factor, the Salinas yield tests may not clearly differentiate it from the susceptible check(s), but then probably neither would an individual root scoring system. Likewise, varieties with differences in the frequency of the Rz factor will probably not be clearly differentiated.

PERFORMANCE OF CHECK VARIETIES
UNDER RHIZOMANIA CONDITIONS

		Moderate	Severe	5 Mo	4 Mo	I.V.
Planted		4/28	4/28	6/05	8/1	9/24
Harvested		10/28	11/05	11/16	12/3	6/30
Variety	Description	Sugar Yield (lbs/a)				
US H11	Susc.hybrid	4600	2700	1000	600	3000
Rhizosen	Holly(Rz)	7900	5900	2700	1900	6400
Rima	SES	8200	6400	2700	1800	7000
C39R5	USDA lines	9300	6500	3600	1900	--
LSD (.05)		990	1400	500	270	1100

I.V. = Imperial Valley test.

SOURCES OF RESISTANCE TO RHIZOMANIA - As summarized in the following tables, resistance to rhizomania from a number of unique sources is being investigated at Salinas. These sources of resistance include both qualitative and quantitative resistance. Resistance was found both within cultivated beet and wild beet (B.maritima). Performance trials suggested that the factors conditioning resistance from these sources may be different. This commonality of factors is being investigated. Of particular interest at this time is the resistance found within line R22 (C50) that was derived from many different B.maritima sources. In tests at both Salinas and Brawley under severe rhizomania conditions, R22 germplasm showed the least damaging effects due to rhizomania.

SOURCES OF RESISTANCE TO RHIZOMANIA
IN PROGRAM AT SALINAS

Quantitative within sugarbeet	
C39R	Reselected USDA germplasm
C47R	Reselected USDA germplasm
C94,R20	Reselected Ft.Collins gp, Rhizoc.res.
R03,R05	Reselected Alba/Italian gp, CLSR
Qualitative	
Rz	Holly source of resistance
C28,PI07	PI206407, Chard type, Turkey
SES	Resistance from Rizor
Beta maritima	

SOURCES OF RESISTANCE TO RHIZOMANIA FROM
WILD BEET, WEED BEET, AND/OR BETA MARITIMA

Enhanced germplasm Line designation	Description
R21, C48	SB x WB41,WB42. B.m.,Denmark,(1952)
R24	SB x WB42. B.m.,Denmark
R22, C50	SB x B.maritima collection (60 WB lines)
R04	SB x Italian accession (SB x WB)
90-WB1	SB x WB169, Italy, 1971 Coons
90-WB2	SB x WB258, Italy, 1979 DeBiaggi
90-WB3	SB x WB(SP663000-0), Denmark
90-WB4	SB x WB151, Denmark
Not enhanced germplasm	
PI's	B.maritima from Greece, France, Ireland, U.K., etc.

SB = one or more crosses and BC's to sugarbeet

PERFORMANCE OF ENHANCED SUGARBEET x WB
(B.MARITIMA) GERMPLASM UNDER MODERATE RHIZOMANIA

Variety	Description	Sugar Yield	% S
US H11		4400	11.5
Rhizosen		7800	14.4
Rima		7700	15.1
C39R5		8800	14.9
C37	Susc.SB recurrent parent	5400	13.7
C37Rz		6900	14.1
R21,C48	SB x WB41,WB42,Denmark	6600	14.5
R22R3,C50	SB x WB collection	9200	14.2
R32	SB x R04 (Italian SBxWB)	8400	12.8
90-WB1	SB x WB169, Italy	7500	13.5
90-WB2	SB x WB258, Italy	8200	15.0
90-WB3	SB x WB (SP663000-0)	7400	14.9
90-WB4	SB x WB151,Denmark	8400	15.7
LSD (.05)		1100	0.7

SB = one or more crosses and BC's to sugarbeet

RESPONSE OF LINE R22 (C50) TO SELECTION
R22 = F_3 (Y54 x B.maritima collection)

		Sugar Yield (lbs/a)		
Variety	Cycle	Non-dis.[1]	Moderate[2]	Severe[3]
Y54	SB parent	100	100	100
R80	Y54Rz	103	154	275
R22	CO,source	77	118	128
R22R3	C3,rhizomania	91	165	306
Test mean		15400	7200	2400
LSD (.05)		12	16	20

[1]Test 1192-3, pltd 1/22, harv 10/6/92.
[2]Test 2692-4, pltd 4/28, harv 11/4/92.
[3]Test R692, pltd 6/5, harv 11/18/92.

PERFORMANCE UNDER MODERATE vs
SEVERE RHIZOMANIA, SALINAS

	Sugar Yield		
Variety	Moderate	Severe	Difference
US H11	4500	2700	40%
Rizor	8000	5600	30
Rhizosen	8000	5900	26
C39R7	9200	6500	29
R22R3, SB x B.m.	9000	8400	6
LSD (.05)	1000	1400	

Test 2592; pltd 4/28; harv 10/28/92.

TEST 992. EVALUATION OF POPN-790 LINES AND SYNTHETICS, SALINAS, CA., 1992

12 entries x 8 replications, RCB
1-row plots, 18 ft. long

Planted: January 22, 1992
Harvested: September 24, 1992

Variety		Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	NSSS %	RJAP %	Beets/ 100' No.	Bolters %	Powdery Mildew[2] Mean
Set 1 (992-1) Synthetics CO:C4:C5										
8790L	C4	7790Laa x A	13447	52.61	12.8	2.2	85.3	158	0.0	3.5
0790	C5	8790-S_1(C)aa x A	13012	52.03	12.5	2.1	85.7	152	0.0	3.2
1890	R_Z	RZM 0790H124(A,aa)	12998	47.64	13.7	2.5	84.7	149	0.0	3.6
7790C	CO	7790Caa x A	7640	33.30	11.5	2.6	81.3	148	0.0	3.3
Set 2 (992-2) Hybrids										
R080H30		C790-15aa x R980	18255	60.22	15.1	2.7	85.0	148	0.0	1.6
R080H29		C790- 6aa x R980	17248	58.43	14.8	2.6	85.2	156	0.4	3.2
R080H89		88-790-68CMS x R980	16337	54.92	14.9	2.5	85.7	143	0.4	2.4
R080H90		8790Laa x R980	16296	55.81	14.6	2.7	84.5	151	0.0	3.3
R080H33		C790-54aa x R980	16155	54.97	14.7	2.7	84.3	148	0.4	3.5
R080H34		8790-55aa x R980	15855	55.02	14.4	2.7	84.3	161	0.0	2.8
Y846H36		7790Laa x Y746	15441	55.34	13.9	2.4	85.3	152	0.0	2.6
Y846H32		7790Caa x Y746	12537	46.57	13.4	2.5	84.1	158	0.0	2.8
Mean			14601	52.24	13.9	2.5	84.6	151.8	0.1	3.0
LSD (.05)			1314	4.02	0.6	0.3	1.7	10.2	0.6	0.6
C.V. (%)			9.04	7.73	4.4	12.1	2.0	6.7	555.3	21.6
F value			37.61**	24.91**	27.9**	3.4**	3.9**	2.1*	0.9NS	6.2**

TEST 1192-1. YIELD EVALUATION OF MULTIGERM GERMPLASM, SALINAS, CA., 1992[1,2]

16 entries x 6 replications, RCB
1-row plots, 20 ft. long

Planted: January 22, 1992
Harvested: October 6, 1992

Variety[4]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Bolters %	Beets/ 100' No.	RJAP %	Powdery Mildew[3] Mean
768	Inc. 868 (US 75)	12740	43.77	14.6	0.0	0.0	142	86.7	4.6
U86-37	Inc. C37 (86443)	12982	40.95	15.8	0.0	0.0	151	84.0	3.8
R079	RZM R979 ($C37R_Z$)	13571	43.26	15.7	0.0	1.1	158	85.0	3.2
1204-#	R079 x C37	12112	39.76	15.2	0.0	0.0	145	84.0	4.2
R028	RZM 9221	15218	49.63	15.4	0.0	7.3	155	84.4	4.2
R128	RZM 0271-#	13461	42.84	15.7	2.1	5.9	133	85.6	4.0
1202-#	0271 x C37	13675	43.96	15.6	0.0	0.0	146	84.7	4.3
R130	RZM R030	15178	48.89	15.5	0.0	4.7	159	84.1	3.0
R104	RZM R004	11993	42.98	14.0	0.0	25.8	148	83.3	3.2
1201-#	R004 x C37	14465	47.67	15.2	0.0	3.4	143	84.7	2.8
R121	BYR R921, R924, R925	15370	46.69	16.5	0.0	0.0	152	83.4	4.3
1211-16-#	C37 x (SB x WB97, 242)	14030	44.59	15.7	0.0	6.4	140	85.7	2.7
Y148	BYR Y948 (C93)	16010	47.67	16.8	0.0	0.0	153	86.6	3.1
Y141	BYR Y941 (C91)	17031	52.43	16.3	0.0	0.0	153	85.7	1.1
Y156	BYR Y956	15525	51.03	15.3	0.0	0.0	158	86.5	3.0
US H11	L113401	13221	49.42	13.4	0.0	0.5	160	85.4	4.5

TEST 1192-1. YIELD EVALUATION OF MULTIGERM GERMPLASM, SALINAS, CA., 1992[1,2]

(cont.)

Variety[4]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Bolters %	Beets/ 100' No.	RJAP %	Powdery Mildew[3] Mean
Mean		14161.5	45.97	15.4	0.1	3.4	150.0	85.0	3.5
LSD (.05)		1808.0	5.76	0.7	1.5	3.8	18.5	3.2	0.6
C.V. (%)		11.1	10.89	4.0	979.8	95.7	10.7	3.3	15.2
F value		5.1**	3.32**	11.5**	1.0NS	23.6**	1.4NS	0.9NS	18.1**

[1]TEST 1192. YIELD EVALUATION OF MULTIGERM GERMPLASM.
64 entries x 6 replications, Incomplete blocks with 4 subsets each, 16 varieties x 6 replications, RCB. Thus means across Tests 1192-1,-2,-3,-4 can be compared. See Test 2692 for performance under more severe rhizomania and Test 2892 for performance under severe BYV/BWYV conditions.

Mean	15535.5	49.32	15.7	0.3	1.5	151.3	84.9	3.0
LSD (.05)	2013.0	5.82	0.8	1.4	2.7	13.1	2.8	0.7
C.V. (%)	11.4	10.39	4.7	397.8	160.1	7.6	2.9	20.9
F value	6.0**	5.37**	6.6**	1.7**	20.8**	2.7**	1.3NS	12.2**

[2]Test 1192 was grown in Block 3. Soil in block 3 tested positive for BNYVV; however, because of the winter planting, rhizomania symptoms and affects appeared to be mild. Rhizomania probably caused some differential affects, particularly decreasing % sucrose for highly susceptible entries, e.g., 6625, US H11, HH37, etc. Entries not considered rhizomania resistant but with some tolerance, appeared to have near normal performance, e.g., Y141, Y139, Y049, etc. Virus yellows was moderate. BWYV infection occurred early. BYV infection occurred late in the season and spread from the BYV/BWYV inoculated tests. Black aphids required periodic control. Curly top infection occurred but mostly after plants were 3-4 months old, and appeared to affect only highly susceptible entries, e.g. 6625, R106, etc.

[3]Mean score for powdery mildew scored 8/3,8/12,8/20 & 8/27 where 9 = highly susceptible. PM was controlled through most of summer with Bayleton.

TEST 1192-2. YIELD EVALUATION OF MULTIGERM GERMPLASM, SALINAS, CA., 1992

16 entries x 6 replications, RCB
1-row plots, 20 ft. long

Planted: January 22, 1992
Harvested: October 6, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Bolters %	Beets/ 100' No.	RJAP %	Powdery Mildew[3] Mean
U86-46/2	Inc. C46/2 (86342)	14597	45.84	15.9	1.1	0.0	148	84.7	1.9
R078	RZM R978C2 ($C46R_Z$)	17342	53.69	16.2	0.0	0.0	152	85.3	2.0
Y931-43	Inc. Y731-43	15842	50.82	15.5	0.0	0.0	148	83.7	2.7
Y131-43	BYR Y931-43 (C31-43)	16120	53.41	15.1	0.0	0.0	154	84.6	2.0
R176-43-#	Y931-43 x R076	16566	52.43	15.8	0.0	0.0	153	86.8	2.5
R176-89-#	Y931-89 x R076	18593	56.35	16.5	0.0	0.0	150	85.4	2.7
Y131-89	BYR Y931-89 (C31-89)	15878	50.33	15.8	0.0	0.0	152	84.9	3.2
Y931-89	Inc. Y731-89	15278	47.67	16.0	0.0	0.0	149	83.6	2.6
F86-31/6	Inc. C31/6 (86263)	15746	53.06	14.9	0.0	0.0	158	83.3	2.1
R076	RZM R976 ($C31R_Z$)	17847	56.07	15.9	0.0	0.0	148	85.3	3.3
R070	Inc. R971-R980[2]	17525	55.30	15.8	0.0	1.1	152	83.6	3.0
Y049	BYR-ER-PMR Y849 (C49)	18349	55.09	16.7	0.0	0.0	150	86.1	1.5
1913	RZM 0913 (A,aa)	18326	56.07	16.3	0.0	0.5	158	85.3	2.7
0915	9903aa x 9911H49	17110	54.38	15.8	1.2	0.0	146	84.6	2.8
1915	RZM 0915 (A,aa)	17469	53.76	16.3	0.0	0.0	153	84.4	2.8
HH 37	L373409	13675	48.23	14.2	3.1	0.0	163	85.7	3.4
Mean		16641.4	52.66	15.8	0.3	0.1	152.0	84.8	2.6
LSD (.05)		1908.0	5.5	0.8	1.4	0.6	9.0	3.1	0.7
C.V. (%)		10.0	9.04	4.5	369.2	530.2	5.1	3.1	25.1
F value		4.4**	2.75**	4.9**	2.7**	1.8*	2.1*	0.8NS	4.3**

[3]Mean score for powdery mildew scored 8/3,8/12,8/20 & 8/27 where 9 = highly susceptible. PM was controlled through most of summer with Bayleton.

TEST 1192-3. YIELD EVALUATION OF MULTIGERM GERMPLASM, SALINAS, CA., 1992

16 entries x 6 replications, RCB
1-row plots, 20 ft. long

Planted: January 22, 1992
Harvested: October 6, 1992

Variety[5]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Bolters %	Beets/ 100' No.	RJAP %	Powdery Mildew[3] Mean
HH66	L663302	14209	49.14	14.4	0.5	0.0	169	86.8	3.8
Y054-23	Inc. Y854-23	16653	53.62	15.5	0.0	0.0	144	83.6	1.9
Y054-38	Inc. Y854-38	16315	51.87	15.7	0.0	0.0	155	83.8	1.5
Y054	BYR-ER-PMR Y854 (C54)	15027	47.18	15.9	0.0	0.6	152	85.9	2.3
R080	Inc. R980	16462	50.12	16.4	0.0	0.0	148	85.2	2.6
R080	RZM R980 ($C54R_Z$)	18066	55.37	16.3	0.0	0.0	160	86.7	3.5
Y954	Inc. Y854	15957	50.61	15.7	1.1	0.0	158	85.6	2.5
R722	Inc. F_2 (Y54 x B.m.)	12387	41.93	14.8	0.5	22.6	158	83.1	3.1
R022Y	Inc. R922Y	15474	49.49	15.6	0.0	0.0	153	84.4	3.0
R122Y2	BYR R922Y	15914	50.19	15.9	0.0	0.0	159	83.7	3.1
R022R2	RZM R922R	14460	47.60	15.2	0.0	7.3	160	83.8	3.7
R122R3	RZM R022R2	14598	47.18	15.5	0.5	4.9	168	81.2	4.5
R105	RZM R005	14768	43.54	17.0	0.0	0.0	155	83.3	3.4
R106	RZM R006	14638	44.24	16.5	2.7	0.0	148	84.4	3.2
R107	RZM R007	15790	50.40	15.7	0.0	0.0	151	84.0	3.8
R108	RZM R008	15920	50.19	15.8	0.0	0.0	148	85.7	2.7
Mean		15414.7	48.92	15.7	0.3	2.2	155.3	84.4	3.0
LSD (.05)		1807.0	5.04	0.7	1.0	3.9	10.8	2.4	0.7
C.V. (%)		10.2	8.96	4.1	269.7	152.2	6.0	2.5	20.2
F value		4.0**	3.95**	5.8**	3.8**	18.0**	3.4**	2.9**	9.4**

[3]Mean score for powdery mildew scored 8/3,8/12,8/20 & 8/27 where 9 = highly susceptible. PM was controlled through most of summer with Bayleton.

[5]Y054 = C54. Y954 = Y54, sugarbeet parent of R722. R722 = F_3 (Y54 x B.maritima lines) = C50, used as source for rhizomania (RZM) and virus yellows resistant selection. R022Y and R122Y2 = C1 and C2 for VYR selection. R022R2 and R122R3 = C2 and C3 for RZM. R105 and R106 = RZM from Italian lines; R107 and R108 = crosses to Salinas lines.

TEST 1192-3. YIELD EVALUATION OF MULTIGERM GERMPLASM, SALINAS, CA., 1992

16 entries x 6 replications, RCB
1-row plots, 20 ft. long

Planted: January 22, 1992
Harvested: October 6, 1992

Variety[6]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Bolters %	Beets/ 100' No.	RJAP %	Powdery Mildew[3] Mean
6625	Beta 6625 (0011-1)	14174	46.20	15.3	1.0	0.0	161	86.3	3.7
Z010	Inc. Polish C	13645	41.30	16.5	0.0	0.0	135	85.2	4.3
Z120	RZM Z010H12	16102	48.02	16.8	0.0	1.1	150	85.5	3.8
Z012	Inc. Polish 2	14511	44.38	16.4	0.0	0.0	129	84.9	4.3
Z122	RZM Z012H12	17264	53.41	16.2	0.5	0.0	157	85.2	3.4
Z014	Inc. Polish 4	11114	33.01	16.9	1.9	0.5	134	86.1	4.0
Z124	RZM Z014H12	16335	49.91	16.4	1.1	0.0	154	84.3	3.2
Y147	BYR Y947 (C47)	17080	52.08	16.4	0.0	0.0	153	85.9	2.0
R047C5	Inc. R947C5 (C47R5)	16088	53.06	15.1	0.0	0.5	150	84.7	3.4
R047C7	RZM R047C6 (C47R7)	16456	53.20	15.5	0.0	0.0	155	84.3	3.0
Y139	BYR Y939 (C39)	17994	51.14	17.6	0.0	0.0	149	86.0	1.5
R039C5	Inc. R939C5 (C39R5)	19063	57.68	16.5	0.5	1.2	143	86.1	1.5
R139C7	RZM R039C6 (C39R7)	18101	55.65	16.3	1.7	0.0	147	85.0	1.2
R119	RZM 901008,89141	15663	49.84	15.7	0.6	0.0	157	86.5	2.4
R120	RZM R020 (C94)	14887	53.27	13.9	0.5	1.1	154	85.3	2.8
1914	RZM 0914	16315	53.62	15.2	0.0	0.0	141	85.7	1.6
Mean		15924.5	49.74	16.0	0.5	0.3	148.1	85.4	2.9
LSD (.05)		1955.0	5.28	0.9	1.7	1.1	11.2	2.6	0.8
C.V. (%)		10.7	9.23	5.1	296.4	327.7	6.6	2.6	22.8
F value		7.9**	10.73**	7.0**	1.2NS	1.5NS	5.3**	0.6NS	15.9**

[3]Mean score for powdery mildew scored 8/3,8/12,8/20 & 8/27 where 9 = highly susceptible. PM was controlled through most of summer with Bayleton.

[6]Z010 & Z012 = increases of 2N-Polish-Z lines; Z010 = increase of composite of 2N-Polish-Z lines; Z120, Z122, & Z124 = F_2 (popn-912$R_z$aa x Polish). R119 = RZM from rhizoctonia resistant selections from C94. R120 = C94. 1914 = S^2 C39.

TEST 1092. YIELD EVALUATION OF SELF-FERTILE LINES AND POPULATIONS, SALINAS, CA., 1992[1]

48 entries x 6 replications, RCB
1-row plots, 20 ft. long

Planted: January 22, 1992
Harvested: October 8, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Mean	RJAP %
Set 1 (1092-1)									
US H11	L113401	12806	47.32	13.6	0.0	1.0	159	4.2	83.3
5747	4747aa x A	14616	52.54	13.9	0.5	0.6	148	3.7	83.6
9910	8910aa x A	16987	55.51	15.3	0.0	0.0	147	3.5	83.9
R129	RZM 0281-#	14173	47.94	14.8	1.8	0.0	145	3.5	83.6
R131	RZM R031	16334	51.09	16.0	2.1	0.0	154	4.7	84.0
8909	7909aa x A	17100	53.72	15.9	0.6	0.0	149	3.0	85.3
1907-14	RZM 9907-14	13875	43.75	15.9	0.0	0.6	144	3.3	83.0
1908- 7	RZM 9908- 7	14483	48.23	15.0	0.0	0.5	146	3.2	84.0
1909-13	RZM 9909-13	10047	32.55	15.4	0.0	0.6	139	4.6	82.6
0909- 7	Inc. 8909A-7	14133	44.03	16.1	0.5	0.0	152	3.5	83.6
0909-34	Inc. 8909A-34	16715	51.99	16.1	0.5	0.0	141	1.9	85.6
0909-37	Inc. 8909A-37	18536	57.61	16.1	0.0	0.0	154	2.0	85.6
Mean		14983.7	48.86	15.3	0.5	0.3	148.1	3.4	84.0
LSD (.05)		1921.0	5.82	0.7	1.4	1.3	12.7	0.7	2.8
C.V. (%)		11.1	10.30	3.7	233.4	402.0	7.4	17.9	2.9
F value		11.5**	10.60**	14.2**	2.2*	0.7NS	1.7NS	12.1**	1.0NS

[1]TEST 1092. YIELD EVALUATION OF SELF-FERTILE LINES AND POPULATIONS
48 entries x 6 replications, Incomplete blocks with 4 subsets each, 12 varieties x 6 replications, RCB.
Thus means across Tests 1092-1,-2,-3,-4 can be compared.

Mean	14851.7	48.53	15.3	0.2	0.2	147.4	3.3	83.8
LSD (.05)	2284.0	7.11	0.8	0.8	1.1	12.3	0.8	2.9
C.V. (%)	13.5	12.89	4.9	418.1	384.6	7.3	20.2	3.1
F value	6.6**	5.42**	7.1**	2.1**	0.7NS	1.5*	11.3**	1.4NS

TEST 1092. YIELD EVALUATION OF SELF-FERTILE LINES AND POPULATIONS, SALINAS, CA., 1992

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Mean	RJAP %
Set 2 (1092-2)									
0911	RZM 9911	16742	53.11	15.8	0.0	0.0	152	2.7	85.1
0911	9911aa x 9911,9911H49	13208	43.70	15.3	0.6	0.6	145	3.1	84.4
1911- 4	Inc. 9911- 4	16511	49.98	16.5	0.0	0.5	151	2.1	82.8
1911-12	Inc. 9911-12	15869	48.65	16.3	0.0	0.5	148	2.4	83.1
1911-14	Inc. 9911-14	15111	47.32	16.0	0.0	0.0	148	2.7	83.5
1911-50	Inc. 9911-50	15967	51.10	15.6	0.0	0.0	149	2.0	83.8
9912	RZM 8909,..,8911aa x A	17778	57.14	15.6	0.0	0.0	139	2.9	84.1
1912-3	Inc. 9912-3	16386	56.97	14.3	0.0	0.0	148	2.9	81.5
1912-11	Inc. 9912-11	15146	47.73	15.8	0.6	0.0	150	3.3	85.9
U86-37	Inc. C37 (86443)	12593	41.84	15.1	0.0	0.0	156	3.6	84.5
U86-46/2	Inc. C46/2 (86342)	14484	46.85	15.5	0.0	0.0	145	2.4	82.8
HH37	L373409	13593	49.42	13.7	0.0	0.6	152	3.5	84.1
Mean		15282.4	49.48	15.5	0.1	0.2	148.6	2.8	83.8
LSD (.05)		3015.0	9.34	0.9	0.6	0.9	10.8	0.8	3.5
C.V. (%)		17.1	16.32	4.9	572.1	399.9	6.3	24.2	3.6
F value		2.2*	1.99*	6.5**	1.0NS	0.8NS	1.2NS	3.6**	0.9NS
Set 3 (1092-3)									
0913	9911H49aa x 9911,9911H49	16691	53.41	15.7	0.0	0.6	148	2.3	82.2
0913	RZM 9911H49	16241	50.52	16.1	0.0	0.0	141	2.5	86.5
1913	RZM 0913 (Sp)	17617	55.01	16.0	0.5	0.6	148	2.6	83.7
1913- 5	Inc. 9911H49- 5	16351	53.55	15.3	0.0	0.0	143	2.1	84.2

TEST 1092. YIELD EVALUATION OF SELF-FERTILE LINES AND POPULATIONS, SALINAS, CA., 1992

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Mean	RJAP %
Set 3 (1092-3) (cont.)									
1913-18	Inc. 9911H49-18	18163	59.64	15.2	0.0	0.0	142	2.5	83.4
1913-22	Inc. 9911H49-22	16198	51.84	15.6	0.0	0.0	138	2.3	84.1
1913-25	Inc. 9911H49-25	15924	51.31	15.5	0.0	0.0	151	2.3	83.9
0915	9903aa x 9911,9911H49	17703	56.59	15.6	0.0	0.0	148	2.8	85.1
1915	RZM 0915	16453	52.71	15.6	0.6	0.0	138	2.6	83.5
1905	BYR 9905	13765	47.81	14.4	0.0	0.6	147	2.7	84.7
N152	NR-RZM 0204-2(C)	11251	42.55	13.2	0.0	0.5	137	4.6	80.3
6625	0011-1 Beta	13791	46.90	14.7	0.0	0.0	156	4.1	84.7
Mean		15845.7	51.82	15.3	0.1	0.2	144.7	2.8	83.9
LSD (.05)		2109.0	6.34	0.7	0.7	0.9	11.0	0.7	2.7
C.V. (%)		11.5	10.57	4.2	606.8	424.3	6.6	21.3	2.8
F value		7.1**	4.16**	9.4**	0.9NS	0.7NS	2.3*	10.0**	2.5*
Set 4 (1092-4)									
0790	8790-S_1(C)aa x A	13622	48.58	14.0	0.0	0.0	156	3.5	84.2
1890	RZM 0790H124	14435	47.60	15.2	0.0	0.6	148	4.0	84.2
0787	BYR 8787	10126	39.04	13.0	0.0	1.1	154	3.3	83.4
1887	RZM 0887	12686	43.33	14.7	0.0	0.5	150	4.3	80.7

TEST 1092. YIELD EVALUATION OF SELF-FERTILE LINES AND POPULATIONS, SALINAS, CA., 1992

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Mean	RJAP %
Set 4 (1092-4) (cont.)									
1859	NB 9859m	11105	36.61	15.1	0.0	0.6	146	5.2	83.5
1859R	RZM 0859	12994	41.37	15.7	0.0	0.6	143	5.5	83.9
1865	RZM 0865	12519	39.97	15.6	0.0	0.0	151	4.8	81.5
1864	RZM 0864	12882	40.88	15.8	0.0	0.0	155	3.5	83.8
1867	NB 9867m	12725	40.37	15.8	0.0	0.6	143	3.6	84.0
1867R	RZM 0867	17022	54.74	15.5	0.0	0.0	148	4.3	85.3
1866	RZM 0866	15442	49.64	15.6	0.0	0.0	146	4.3	83.6
1876	RZM 0876	13984	45.39	15.5	0.0	0.0	139	3.8	84.3
Mean		13295.1	43.96	15.1	0.0	0.3	148.3	4.2	83.5
LSD (.05)		1503.0	4.60	1.0	---	1.1	10.4	0.7	2.8
C.V. (%)		9.8	9.05	5.6	---	291.5	6.1	14.3	2.9
F value		11.9**	10.63**	6.1**	---	0.9NS	2.0*	8.7**	1.6NS

TEST 1292. TEST AND RETEST OF SELECTED PROGENIES IN EXPERIMENTAL HYBRIDS, SALINAS, CA., 1992

32 entries x 8 replications, RCB equalized
1-row plots, 30 ft. long

Planted: January 22, 1992
Harvested: October 1, 1992

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	Powdery Mildew Mean[2]	RJAP %
Checks								
US H11	L113401HS	11674	46.83	12.4	0.5	162	5.2	83.8
HH 66	L663302HS	12254	46.27	13.2	0.8	158	4.5	86.4
4757	Beta (1/6/89)BS	16722	56.46	14.8	0.0	162	3.3	85.3
HH 37	L373409HS	12244	46.65	13.0	0.3	154	4.5	83.6
6625	Beta 0011-1 (1/4/91)	12491	43.99	14.2	0.8	155	5.4	85.7
Y931DH20	87-309H3 x Y731D	13638	48.76	14.0	0.3	159	4.6	84.8
Y047H20	87-309H3 x Y947	14338	48.55	14.8	0.0	160	5.2	85.5
Y039H20	87-309H3 x Y939	14592	48.51	15.0	0.0	160	4.6	86.1
Y931-43 & 89H20	87-309H3 x Y831-43,-89	14965	51.17	14.6	0.3	151	5.4	85.1
Z010H20	87-309H3 x Polish (C)	12880	45.40	14.2	0.0	160	6.5	86.1
C54 progenies								
R080H20	87-309H3 x R980	14499	49.46	14.6	0.0	158	5.8	85.5
Y054H20	87-309H3 x BYR Y854	12965	45.85	14.1	0.0	157	4.9	85.5
Y054-38H20	87-309H3 x Y854-38	13716	47.80	14.4	0.3	144	4.6	84.1
Popn-907, -908, -909 progenies								
1907-14H20	87-309H3 x RZM 9907-14	16460	52.01	15.8	0.0	159	5.9	85.5
1908- 7H20	87-309H3 x RZM 9908- 7	15311	51.10	15.0	0.0	157	5.8	85.5
1909-13H20	87-309H3 x RZM 9909-13	13382	44.31	15.1	0.3	154	6.8	85.4
Popn-909 progenies								
0909- 7H20	87-309H3 x 8909A- 7	13802	48.26	14.3	0.0	147	5.0	84.4
0909-34H20	87-309H3 x 8909A-34	14677	48.97	14.9	0.0	159	4.5	85.6
0909-37H20	87-309H3 x 8909A-37	15177	50.32	15.1	0.0	157	4.4	85.7

TEST 1292. TEST AND RETEST OF SELECTED PROGENIES IN EXPERIMENTAL HYBRIDS, SALINAS, CA., 1992

(cont.)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	Powdery Mildew Mean[2]	RJAP %
Popn-911, -913, -915 progenies								
0913H39	89-762-17CMS x 9911H49	15934	55.65	14.3	0.0	154	4.3	85.6
0913H20	87-309H3 x 9911H49	14543	49.07	14.8	0.0	158	5.4	83.7
9912H20	87-309H3 x RZM 8909-8911	15191	50.82	15.0	0.0	159	5.7	83.4
1911- 4H20	87-309H3 x 9911- 4	15920	49.42	16.1	0.0	148	4.9	84.0
1911-12H20	87-309H3 x 9911-12	14126	46.51	15.2	0.0	149	5.2	84.0
1911-14H20	87-309H3 x 9911-14	15720	50.05	15.7	0.0	145	5.1	85.1
1911-50H20	87-309H3 x 9911-50	16004	52.60	15.2	0.0	158	5.0	86.7
1912- 3H20	87-309H3 x 9911- 3	13008	48.04	13.5	0.3	147	5.4	85.9
1912-11H20	87-309H3 x 9912-11	13670	48.65	14.1	0.3	162	5.6	86.2
1913- 5H20	87-309H3 x 9911H49- 5	14590	50.54	14.4	0.0	139	5.3	87.1
1913-18H20	87-309H3 x 9911H49-18	14449	51.15	14.1	0.0	138	5.4	83.5
1913-22H20	87-309H3 x 9911H49-22	13291	46.65	14.3	0.3	139	4.8	84.9
1913-25H20	87-309H3 x 9911H49-25	14155	48.12	14.7	0.3	136	5.5	85.3
Mean		14262.2	49.00	14.5	0.1	153.3	5.1	85.2
LSD (.05)		1222.5	3.53	0.6	0.6	7.4	0.8	2.0
C.V. (%)		8.7	7.31	4.4	414.3	4.9	15.9	2.4
F value		8.6**	4.99**	11.8**	1.1NS	8.5**	5.5**	1.9**

[1]See tests 1092 and 1692. 87-309H3 = C562CMS x C309.

[2]Powdery mildew scored 8/3, 8/12, 8/20, & 8/27 on a scale of 0 to 9.

TEST 1492. HYBRID PERFORMANCE OF MONOGERM LINES, SALINAS, CA., 1992

32 entries x 8 replications, RCB equalized
1-row plots, 28 ft. long

Planted: January 22, 1992
Harvested: September 21-23, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Bolters %	Beets/ 100' No.	RJAP %	Powdery Mildew Mean
Checks									
4757	Beta (1/6/89)	17124	56.17	15.3	0.0	0.3	156	85.4	3.2
HH37	L373409	14278	51.23	14.0	0.0	0.0	152	85.7	4.2
6625	Beta 0011-1	13999	44.63	15.7	0.0	0.0	146	85.1	5.1
HH66	L663302	13860	50.17	13.8	0.0	0.0	156	83.7	4.2
US H11	L113401	13606	49.46	13.8	0.0	0.0	155	83.9	4.6
mm lines x R80									
R080H30	C790-15aa x R980	18165	58.93	15.4	0.0	0.0	155	83.6	2.4
R080H29	C790-6aa x R980	17456	58.35	15.0	0.0	0.3	151	83.4	4.2
R080H34	8790-55aa x R980	17286	55.66	15.5	0.0	0.3	152	84.8	4.8
R080H33	C790-54aa x R980	17226	57.36	15.1	0.0	1.1	157	84.4	4.1
R080H39	89-762-17CMS x R980	17195	58.61	14.7	0.0	0.3	149	84.2	3.9
R080H90	8790Laa x R980	16730	55.93	15.0	0.0	0.0	152	84.5	4.0
R080H89	88-790-68CMS x R980	16642	54.11	15.4	0.0	0.3	141	83.5	3.7
R080H18	88-790-68H26 x R980	16332	52.88	15.4	0.0	0.0	144	83.7	4.4
R080H20	87-309H3 x R980	15932	51.46	15.5	0.0	0.0	149	83.2	4.8
R080H26	87-309CMS x R980	15264	49.21	15.5	0.0	0.0	149	82.3	4.9
R080H3	F82-562HO x R980	14561	49.94	14.6	0.0	0.0	156	84.1	4.2
mm popns x R80									
R080H113	9867H67aa x R980	16855	54.61	15.4	0.0	0.0	144	83.4	4.0
R080H133	9864aa x R980	16618	54.60	15.3	0.0	1.1	149	83.4	3.9
R080H111	9859H6aa x R980	15834	51.19	15.5	0.0	0.0	148	84.4	4.7
R080H132	9865aa x R980	15806	49.70	15.9	0.0	0.6	147	83.0	5.0

TEST 1492. HYBRID PERFORMANCE OF MONOGERM LINES, SALINAS, CA., 1992

(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Bolters %	Beets/ 100' No.	RJAP %	Powdery Mildew Mean
mm lines x popn-913									
0913H39	89-762-17CMS x 9911H49	16819	57.99	14.6	0.0	0.0	150	84.2	3.7
0913H18	88-790-68H26 x 9911H49	16691	55.19	15.2	0.3	0.0	154	84.3	4.7
0913H133	9864aa x 9911H49	16684	54.32	15.4	0.0	0.0	149	84.7	3.3
0913H132	9865aa x 9911H49	16093	52.01	15.5	0.0	0.0	157	81.7	4.4
0913H113	9867H67aa x 9911H49	16084	52.64	15.3	0.0	0.0	144	83.9	3.7
0913H111	9859H6aa x 9911H49	15606	52.16	15.0	0.0	0.0	144	84.3	4.7
790-68H26 x MM lines									
R039C5H18	88-790-68H26 x R939C5(C39R)	17305	55.37	15.6	0.0	0.3	144	83.0	3.4
Y039H18	88-790-68H26 x Y939(C39)	16849	53.58	15.7	0.3	0.6	147	84.7	3.9
Y931DH18	88-790-68H26 x Y731D(C31/6)	16747	54.86	15.3	0.3	0.0	155	84.0	4.0
Y047H18	88-790-68H26 x Y947(C47)	16398	54.76	15.0	0.0	0.0	147	83.4	4.1
R047C5H18	88-790-68H26 x R947C5(C47R)	15723	49.67	15.9	0.0	0.0	154	84.4	4.8
Z010H18	88-790-68H26 x Polish(C)	15571	50.08	15.5	0.0	0.0	153	83.7	6.1
Mean		16166.9	53.34	15.2	0.0	0.2	150.2	83.9	4.2
LSD (.05)		1191.0	3.94	0.8	0.2	0.6	8.7	1.4	0.7
C.V. (%)		7.5	7.50	5.2	917.3	389.8	5.9	1.7	15.7
F value		6.9**	5.53**	3.9**	1.0NS	2.0**	2.2**	2.7**	8.6**

Note: At harvest, a few plants had mod. to severe rhizomania. Most plants did not show root symptoms. Cyst nematodes were present and visable on some roots. Tops suggest moderate N status. Probably 100% BWYV infected.

TEST 1392. AREA 4 CODED VARIETY TRIAL, SALINAS, CA., 1992

32 entries x 8 reps, RCB
1-row plots, 28 ft. long (equalized)

Planted: January 22, 1992
Harvested: September 29, 1992

Code	Variety[1]	Source	Acre Yield		Sucrose	Root Rot	Beets/ 100'	PM Score[2]
			Sugar Lbs	Beets Tons	%	%	No.	Avg
31	R080H30	USDA	17992	55.54	16.2	0.0	140	1.8
1	4757	Betaseed	17826	55.33	16.1	0.0	163	2.0
30	R080H29	USDA	17423	54.57	16.0	0.0	139	3.5
11	9BG6381	Betaseed	17127	54.04	15.9	0.0	153	2.2
32	R080H33	USDA	16814	52.53	16.0	0.0	149	2.6
16	4581	Betaseed	16336	51.13	16.1	0.0	161	2.9
28	Hill 2	Hill-MH	16140	51.85	15.6	0.0	157	3.0
9	9BG6374	Betaseed	16045	51.28	15.6	0.0	139	2.5
23	Rhizosen	Holly	15425	47.83	16.2	0.3	155	4.7
26	9BG6379	Betaseed	15349	49.00	15.7	0.3	136	2.1
18	HH-66	Holly	15211	48.65	15.7	0.3	160	4.3
25	1BG6119	Betaseed	15081	49.32	15.3	0.3	155	2.4
10	90C 63-016	Holly	15065	48.41	15.6	0.3	150	4.6
29	H86558	Spreckels	14726	47.01	15.7	0.0	159	3.2
2	H88242	Spreckels	14672	46.69	15.8	0.0	150	3.4
20	90-1459-0176	Holly	14579	46.65	15.6	0.0	157	4.4
4	9BG6276	Betaseed	14346	47.79	15.1	0.0	151	4.3
15	86C 15-014	Holly	14320	44.76	16.0	0.0	155	5.1
17	9BG6272	Betaseed	14103	45.12	15.7	0.7	123	5.0
5	H87354	Spreckels	14012	45.67	15.4	0.0	152	3.8
6	H90107	Spreckels	13711	46.65	14.7	0.0	158	4.2
14	89-1459-042	Holly	13700	46.80	14.7	0.0	132	3.3
8	HH-41	Holly	13691	47.42	14.4	0.5	160	3.0
19	SS-NB2	Spreckels	13606	44.49	15.3	0.3	152	4.5

TEST 1392. AREA 4 CODED VARIETY TRIAL, SALINAS, CA., 1992

(continued)

Code	Variety[1]	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	PM Score[2] Avg
22	88-1459-049	Holly	13601	44.83	15.2	0.0	161	4.6
7	HM 3023	Hill-MH	13358	47.32	14.1	0.0	153	3.9
13	HH-85	Holly	13204	44.17	14.9	0.8	154	3.4
3	89C 58-010	Holly	13118	43.61	15.1	0.0	160	3.3
21	SS-NB3	Spreckels	13075	44.64	14.7	0.3	152	3.8
24	HH-81	Holly	12941	43.89	14.7	0.0	152	4.1
12	HH-37	Holly	12726	45.92	13.9	0.0	160	3.9
27	US H11	USDA	12672	45.29	14.0	0.0	159	4.4
Mean			14750	48.07	15.3	0.1	152	3.6
LSD (.05)			1181.3	3.26	0.6	0.6	9.9	0.8
C.V. (%)			8.1	6.89	4.0	437.7	6.6	21.8
F value			13.1**	8.91**	9.4**	1.3NS	7.1**	0.8**

TEST 1392. AREA 4 CODED VARIETY TRIAL, SALINAS, CA., 1992

(continued)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
31	R080H30	16486	298	91.6	1505.6	417	1310	454	9047
1	4757	16486	298	92.5	1340.5	605	1219	306	8078
30	R080H29	15987	294	91.8	1435.3	467	1358	390	8730
11	9BG6381	15990	296	93.3	1137.4	543	1122	246	7045
32	R080H33	15535	297	92.4	1278.9	448	1241	361	8106
16	4581	14969	294	91.6	1367.6	551	1415	368	8962
28	Hill 2	14909	288	92.4	1230.9	514	1244	316	7911
9	9BG6374	14840	289	92.5	1204.5	564	1190	301	7807
23	Rhizosen	14330	301	92.9	1095.3	509	1215	300	7672
26	9BG6379	14224	291	92.6	1124.7	730	1213	227	7746
18	HH-66	14035	289	92.2	1176.4	612	1203	311	8102
25	1BG6119	13945	283	92.5	1136.1	624	1157	275	7687
10	90C 63-016	13896	287	92.2	1168.2	640	1136	318	8105
29	H86558	13446	286	91.3	1279.6	571	1423	372	9089
2	H88242	24583	292	92.6	1089.7	460	1160	352	7855
20	90-1459-0176	13511	290	92.7	1067.6	633	1060	292	7640
4	9BG6276	13140	276	91.6	1205.9	919	1116	254	8420
15	86C 15-014	13341	299	93.2	979.2	466	1076	310	7268
17	9BG6272	12870	287	91.2	1232.7	843	1251	327	9289
5	H87354	12943	284	92.3	1069.4	599	1175	295	7839
6	H90107	12666	272	92.3	1045.2	584	1142	277	7528
14	89-1459-042	12579	269	91.7	1120.9	671	1181	293	8083
8	HH-41	12641	266	92.2	1050.6	680	1130	233	7416
19	SS-NB2	12587	283	92.5	1018.8	492	1157	319	7642

TEST 1392. AREA 4 CODED VARIETY TRIAL, SALINAS, CA., 1992

(continued)

Code	Variety	Recover. Sugar lbs/a	Recover. Sugar lbs/t	Recover. Sugar %	Known SugarLoss lbs/a	Sodium ppm	Potassium ppm	NH_2-N ppm	Impur. Value
22	88-1459-049	12567	280	92.4	1033.9	704	1042	278	7707
7	HM 3023	12237	259	91.6	1121.5	836	976	267	7906
13	HH-85	12280	278	92.9	923.9	744	1062	185	7015
3	89C 58-010	12235	282	93.2	883.2	592	1121	203	6803
21	SS-NB3	12084	271	92.4	991.4	643	1149	240	7402
24	HH-81	11913	271	92.0	1027.1	704	1122	264	7780
12	HH-37	11711	256	92.0	1014.5	834	1091	179	7348
27	US H11	11714	259	92.4	957.5	610	1143	217	7052
Mean		13614.9	283.3	92.3	1134.8	619.0	1175.0	291.6	7874.4
LSD (.05)		1123.6	12.3	0.8	134.0	128.0	100.1	64.2	763.9
C.V. (%)		8.4	4.4	0.9	12.0	21.0	8.7	22.4	9.8
F value		12.3**	8.0**	3.2**	9.2**	7.4**	7.8**	7.0**	5.0**

DAVIS 1992. PERFORMANCE UNDER VIRUS YELLOWS CONDITIONS AT DAVIS, CA., 1992[1]

12 varieties x 2 virus trtmts x 6 reps, Split-plot
1-row plots, 30 ft. long

Planted/Watered: May 11, 1992
Harvested: October , 1992
BYV/BWYV Inoc.: June 23, 1992

Variety	Description	Acre Yield[2] Sugar lbs	Beets tons	Sucrose[2] %	Acre Yield[3] Sugar lbs	Beets tons	Sucrose[3] %	Acre Yield[4] Sugar lbs	Beets tons	Sucrose[4] %
Commercial Checks										
HH84	Holly (4/1/92)	7048	22.2	15.7	8895	27.3	16.3	5201	17.1	15.2
4757	Betaseed (1/6/89)	7116	23.4	15.1	9524	30.5	15.7	4709	16.3	14.5
H88199	Spreckels (4/3/92)	7488	23.8	15.6	9393	29.3	16.0	5582	18.4	15.2
USDA Experimental Hybrids										
Y039H18	(C309 x C790-68) x C39	6970	22.0	15.7	8627	26.4	16.4	5313	17.7	15.1
Y047H18	(C309 x C790-68) x C47	7113	22.4	15.8	8942	27.3	16.4	5284	17.4	15.2
Y931DH18	(C309xC790-68)xC31/6(D)	7552	23.9	15.8	9123	28.3	16.1	5980	19.6	15.4
R080H89	C790-68CMS x R980	7000	22.1	15.7	8767	27.0	16.2	5233	17.2	15.2
R080H29	C790- 6aa x R980	7276	23.1	15.6	9090	28.2	16.1	5463	18.0	15.1
R080H30	C790-15aa x R980	7628	24.2	15.7	10169	31.8	16.0	5088	16.6	15.4
R080H33	C790-54aa x R980	7960	25.4	15.6	9968	31.5	15.9	5952	19.3	15.4
USDA Multigerm Line C31-43, -89										
C131-#	YRS Y931-43,-89(Blend)	7521	22.8	16.4	8977	26.4	17.0	6066	19.3	15.8
High %S,VY susceptible check										
6625	Betaseed 0011-1	6762	19.6	17.0	8797	24.8	17.7	4727	14.5	16.4
Mean		7286.1	22.9	15.8	9189.2	28.2	16.3	5383.1	17.6	15.3
LSD (.05)		549.4	1.9	0.4	776.9	2.6	0.6	776.9	2.6	0.6
C.V. (%)		9.3	10.2	3.3	9.3	10.2	3.3	9.3	10.2	3.3
F value		2.6**	4.6**	9.9**	2.6**	2.9**	8.5**	2.6**	2.9**	8.5**
Virus trtmt		**	**	**						
Variety x virus		**	**	NS						

[1]Test was grown by Dr. Steve Kaffka and Gary Peterson at Davis, CA. % sugar and components of impurity were run by Spreckels Sugar, Woodland. Virus inoculum was produced at Salinas.
[2]Variety means over both virus treatments analyzed as RCB (12 x 12 reps).
[3]Variety means for non-inoculated treatment.
[4]Variety means for inoculated treatment.

DAVIS 1992. PERFORMANCE UNDER VIRUS YELLOWS CONDITIONS AT DAVIS, CA., 1992

(cont.)

Variety	Recover. Sugar[2] lbs/a	Recover. Sugar[2] lbs/t	Recover. Sugar[2] %	Known SugarLoss[2] lbs/a	Sodium[2] ppm	Potassium[2] ppm	NH_2-N[2] ppm	Impur.[2] Value	% Loss Sugar[4] lbs/a
HH84	6000	266	84.5	1047.7	442	2091	983	16113	41.5
4757	5927	250	82.6	1189.3	425	2065	1117	17263	50.6
H88199	6269	261	83.3	1218.3	438	2011	1130	17296	40.6
USDA Experimental Hybrids									
Y039H18	5851	262	83.0	1119.2	545	1994	1120	17529	38.4
Y047H18	5894	261	82.5	1218.7	451	1994	1231	18260	40.9
Y931DH18	6224	259	81.9	1327.5	576	2090	1223	18859	39.4
R080H89	5760	258	82.2	1239.4	458	2237	1204	18637	40.3
R080H29	6018	257	82.3	1258.5	421	2066	1237	18393	39.9
R080H30	6293	258	82.2	1334.8	445	2055	1247	18544	50.0
R080H33	6605	260	83.0	1355.4	427	2038	1162	17625	40.3
USDA Multigerm Line C31-43, -89									
C131-#	6306	274	83.4	1215.5	438	2327	1125	18039	32.4
High %S,VY susceptible check									
6625	5758	289	84.8	1004.1	360	1990	1150	17161	46.3
Mean	6075.4	262.9	83.0	1210.7	452.1	2079.9	1160.8	17810.1	
LSD (.05)	459.3	13.4	2.5	234.0	124.7	207.1	209.2	2358.0	
C.V. (%)	9.3	6.3	3.8	23.9	34.1	12.3	22.3	16.4	
F value	2.5**	4.4**	1.0NS	1.7NS	1.6NS	1.9NS	1.0NS	0.9NS	
Non-Inoc. Mean	7782.0	277.0	84.8	1407.0	420.0	2061.0	1038.0	16480.0	
Inoc. Mean	4369.0	249.0	81.2	1014.0	484.0	2099.0	1284.0	19140.0	
Virus trtmt	**	**	**	**	*	NS	*	*	
Var x virus	*	NS	NS	NS	NS	NS	NS	NS	

TEST 2092. NONINOCULATED BYV EVALUATION OF SUGARBEET X BETA MARITIMA POPULATIONS, SALINAS, CA., 1992

8 entries x 2 virus trtmts x 6 reps, Split-block
1-row plots, 20 ft. long, 24 blocks

Planted: February 25, 1992
Harvested: October 07, 1992
Not BYV/BWYV Inoculated

Variety	Description	Acre Yield Sugar[2] lbs	Acre Yield Sugar[6] lbs	Acre Yield Beets tons	Bolters[2] %	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	PM Mean
R122Y2	BYR R922Y	11059	12373	41.19	0.0	15.0	0.0	153	82.2	1.8
R122R3	RZM R022R2	10593	12759	43.74	1.6	14.6	0.0	154	81.6	3.0
Y954	Inc. Y854 (C54)	9625	11607	38.15	0.0	15.2	0.0	147	84.3	1.9
R121	BYR R921, R924, R925 (C48)	9548	11212	36.45	0.0	15.3	0.0	149	84.0	2.9
R022Y	Inc. R922Y	8958	9961	35.72	0.0	14.0	0.0	150	79.3	2.3
R722	Inc. F_2(Y54 x B.m.) (C50)	8610	10114	35.84	7.0	14.1	0.2	155	82.3	2.1
U86-37	Inc. C37 (86443)	8479	9526	33.32	0.0	14.3	0.3	153	83.6	2.8
768	Inc. 868 (US 75)	6200	7882	32.34	0.0	12.2	0.0	142	82.2	3.0
Mean		9134.0	10679.3	37.10	1.2	14.3	0.1	150.9	82.4	2.5
LSD (.05)		868.3	1228.0	4.47	1.1	0.9	0.4	10.2	3.1	0.5
C.V. (%)		11.7	11.7	11.90	130.8	5.4	692.9	8.4	3.3	13.4
F value - varieties		23.5**	23.5**	9.6**	36.7**	25.3**	0.9NS	1.6NS	2.7*	32.3**
F value - virus trtmt.		70.8**	70.8**	62.0**	0.8NS	129.0**	0.0NS	0.1NS	4.4NS	149.0**
F value - var. x virus		1.8NS	1.8NS	1.4NS	1.1NS	0.9NS	1.1NS	1.5NS	1.3NS	5.0NS

[2]Variety means over both virus treatments.

[6]Variety means for noninoculated treatment.

TEST 2092. BYV INOCULATED EVALUATION OF SUGARBEET X BETA MARITIMA POPULATIONS, SALINAS, CA., 1992

8 entries x 2 virus trtmts x 6 reps, Split-block
1-row plots, 20 ft. long, 24 blocks

Planted: February 25, 1992
Harvested: October 07, 1992
BYV/BWYV Inoc.: May 6, 1992

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[7] Rating	PM Mean
R122Y2	BYR R922Y	9744	21.3	33.25	19.3	14.7	2.2	82.6	3.2	3.7
R122R3	RZM R022R2	8428	33.9	30.53	30.2	13.8	5.5	78.9	4.1	5.2
R022Y	Inc. R922Y	7956	20.1	29.75	16.7	13.4	4.1	81.4	3.4	3.8
R121	BYR R921, R924, R925 (C48)	7885	29.7	28.01	23.2	14.1	8.0	82.7	3.6	5.2
Y954	Inc. Y854 (C54)	7643	34.2	26.93	29.4	14.1	7.1	82.3	3.8	2.8
U86-37	Inc. C37 (86443)	7431	22.0	27.02	18.9	13.8	3.8	81.1	2.7	4.6
R722	Inc. F_2(Y54 x B.m.) (C50)	7105	29.8	27.84	22.3	12.7	10.0	79.8	3.4	3.4
768	Inc. 868 (US 75)	4518	42.7	20.86	35.5	10.8	11.1	79.3	4.5	5.8
Mean		7588.6		28.00		13.4		81.0	3.6	4.3
LSD (.05)		1228.0		4.47		0.9		3.1	0.5	0.5
C.V. (%)		11.7		11.90		5.4		3.3	12.7	13.4
F value - varieties		23.5**		9.60**		25.3**		2.7*	9.2**	32.3**
F value - virus trtmt.		70.8**		62.01**		129.0**		4.4NS	---	149.0**
F value - var. x virus		1.8NS		1.35NS		0.9NS		1.3NS	---	5.0**

[7]Mean virus yellows scores from 6/9/92, 6/16/92, 6/29/92 & 7/6/92. Scored from 0 to 9 (100% of matured leaf canopy yellowed).

TEST 1792. NONINOCULATED BYV EVALUATION OF POPN-790, SALINAS, CA., 1992

8 entries x 2 virus trtmts x 6 reps, Split-block
1-row plots, 20 ft. long, 24 blocks

Planted: February 25, 1992
Harvested: October 15 1992
Not BYV/BWYV Inoculated

Variety		Description	Acre Yield Sugar[2] lbs	Acre Yield Sugar[6] lbs	Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	PM Mean
Set 1 (1792-1) Synthetics										
0790	C5	8790-S_1(C)aa x A	9630	11895	45.50	13.08	0.0	165	82.5	4.1
1890	R_Z	RZM 0790H124	9763	11514	39.62	14.53	0.0	158	83.0	5.8
8790L	C4	7790Laa x A	9310	11291	43.95	12.87	0.6	164	83.0	5.2
7790C	CO	7790Caa x A	6492	7866	33.60	11.67	0.3	160	86.2	5.1
Set 2 (1792-2) Hybrids										
R080H30		8790-15aa x R980	14216	16124	53.48	15.08	0.0	159	84.4	2.7
R080H29		8790- 6aa x R980	12976	15276	51.31	14.92	0.0	155	83.4	4.5
R080H33		8790-54aa x R980	13088	15263	51.73	14.73	0.0	162	84.6	4.2
R080H90		8790Laa x R980	12402	14636	49.48	14.85	0.0	155	85.0	4.2
Mean			10984.7	12983.1	46.08	13.97	0.1	159.6	84.0	4.5
LSD (.05)			1069.0	1512.0	5.47	0.70	0.5	8.2	2.7	0.8
C.V. (%)			12.0	12.0	12.09	4.39	535.5	6.4	2.8	13.2
F value - varieties			46.9**	46.9**	22.97**	43.31**	1.7NS	1.7NS	0.8NS	20.8**
F value - virus trtmt.			97.9**	97.9**	65.55**	11.73*	5.0NS	0.2NS	13.1*	152.1**
F value - var. x virus			0.7NS	0.7NS	0.73NS	1.29NS	1.7NS	0.7NS	4.9**	1.3NS

[2]Variety means over both virus treatments.

[6]Variety means for noninoculated treatment.

TEST 1792. BYV INOCULATED EVALUATION OF POPN-790, SALINAS, CA., 1992

8 entries x 2 virus trtmts x 6 reps, Split-block
1-row plots, 20 ft. long, 24 blocks

Planted: February 25, 1992
Harvested: October 15, 1992
BYV/BWYV Inoc.: May 6, 1992

Variety		Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[7] Rating	PM Mean
Set 1 (1792-1) Synthetics											
1890	R_Z	RZM 0790H124	8011	30.4	29.54	24.9	13.45	7.5	82.5	5.2	7.3
0790	C5	8790-S_1(C)aa x A	7364	38.1	28.07	38.3	13.12	-0.3	86.2	5.0	6.9
8790L	C4	7790Laa x A	7328	35.1	28.56	35.0	12.90	-0.3	83.5	5.0	7.2
7790C	CO	7790Caa x A	5119	34.9	22.05	34.4	11.63	0.3	79.3	5.5	7.3
Set 2 (1792-2) Hybrids											
R080H30		8790-15aa x R980	12309	23.7	41.65	22.1	14.77	2.1	83.5	4.1	4.4
R080H33		8790-54aa x R980	10914	28.5	37.59	27.3	14.55	1.2	83.5	3.8	5.7
R080H29		8790- 6aa x R980	10677	30.1	37.66	26.6	14.18	4.9	82.7	4.1	6.1
R080H90		8790Laa x R980	10168	30.5	35.07	29.1	14.50	2.4	81.9	4.6	6.4
Mean			8986.3		32.52		13.64		82.9	4.7	6.4
LSD (.05)			1512.0		5.47		0.70		2.7	0.5	0.8
C.V. (%)			12.0		12.09		4.39		2.8	9.9	13.2
F value - varieties			46.9**		22.97**		43.31**		0.8	10.2**	20.8**
F value - virus trtmt.			97.9**		65.55**		11.73*		13.1*	---	152.1**
F value - var. x virus			0.7		0.73		1.29NS		4.9**	---	1.3NS

[7]Mean virus yellows scores from 6/9/92, 6/16/92, 6/29/92 & 7/6/92. Scored from 0 to 9 (100% of matured leaf canopy yellowed).

TEST 1892. NONINOCULATED BYV EVALUATION OF MULTIGERM LINES, SALINAS, CA., 1992

32 entries x 2 virus trtmts x 6 reps, Split-block
1-row plots, 20 ft. long, 24 blocks

Planted: February 25, 1992
Harvested: October 14, 1992
Not BYV/BWYV Inoculated

Variety	Description[6]	Acre Yield Sugar[2] lbs	Acre Yield Sugar[4] lbs	Acre Yield Beets Tons	Sucrose %	Bolters[2] %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	PM[3] Mean
Checks										
6625	Beta 0011-1(%S,susc.ch.)	9880	12801	43.07	14.8	0.0	1.0	164	82.3	5.1
U86-37	Inc. C37 (86443)	10466	11719	39.70	14.7	0.0	0.0	160	84.6	4.3
R128	RZM 0271-# (C37*3 x PI07)	9681	11328	39.24	14.4	2.4	0.0	158	83.3	3.8
SP7622-0	Inc. SP22-O (L80466)	6232	9293	35.35	13.2	0.0	0.0	169	81.3	3.4
768	Inc. 868 (US 75)	6828	8727	36.82	11.8	0.0	0.6	147	81.6	6.1
C31 lines										
R176-43	Y931-43 x R076(C31-43R_Z)	13665	15285	49.42	15.5	0.0	0.0	158	84.7	3.5
R176-89	Y931-89 x R076(C31-89R_Z)	13853	14803	50.08	14.8	0.0	0.0	149	84.2	2.6
Y931-43	Inc. Y731-43	12654	14232	47.05	15.1	0.0	0.0	156	85.0	3.0
Y931-89	Inc. Y731-89	12377	13772	44.94	15.3	0.0	0.5	162	82.1	3.6
Y131-43	BYR Y931-89 (C31-43)	12377	13363	44.14	15.1	0.0	0.0	159	85.9	2.4
Y131-89	BYR Y931-89 (C31-89)	11728	12712	41.90	15.1	0.0	0.3	158	83.7	3.3
F86-31/6	Inc. C31/6 (86263)	11134	11918	41.86	14.2	0.0	0.3	154	82.2	1.9
VY and/or RZM resistant lines										
R080	RZM R980 (C54R_Z)	12636	14977	50.05	15.0	0.0	0.0	150	80.0	3.9
R122Y2	BYR R922Y (B.m. x Y54)	12404	14729	48.70	15.1	0.0	0.3	151	81.5	2.8
R139C7	RZM R039C6 (C39R)	12890	14723	47.99	15.3	0.0	0.0	145	84.9	1.1
Y147	BYR Y947 (C47)	11934	14639	46.62	15.7	0.0	0.0	156	84.2	1.8
Y139	BYR Y939 (C39)	13041	14075	43.36	16.1	0.0	0.3	151	84.2	1.2
R147C7	RZM R047C6 (C47R)	10922	13572	45.15	15.0	0.0	0.3	163	83.9	3.3
Y141	BYR Y941 (C91)	11564	13177	44.71	14.7	0.0	0.3	153	81.1	1.5
Y148	BYR Y948 (C93)	11272	13105	41.72	15.7	0.0	0.0	157	84.4	2.8
Y054	BYR-ER-PMR Y854 (C54)	11346	13022	43.26	15.0	0.0	0.0	152	84.8	2.5
Y156	BYR Y956	10734	12622	45.71	13.8	0.0	0.0	155	81.6	2.7

TEST 1892. NONINOCULATED BYV EVALUATION OF MULTIGERM LINES, SALINAS, CA., 1992
(cont.)

Variety	Description[6]	Acre Yield Sugar[2] lbs	Acre Yield Sugar[4] lbs	Acre Yield Beets Tons	Sucrose %	Bolters[2] %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	PM[3] Mean
RZM resistant lines										
Z122	RZM Z012H12 [F_2($R_z$aaxP-2)]	10964	13955	45.49	15.3	0.0	0.3	148	83.9	3.8
Z124	RZM Z014H12 [F_2($R_z$aaxP-4)]	11115	13899	44.35	15.6	0.0	0.3	151	83.1	3.4
R107	RZM R007 (Ital.gp.)	11130	13896	45.83	15.1	0.0	0.3	148	83.1	4.9
Z120	RZM Z010H12 [F_2($R_z$aaxP-C)]	11324	13833	43.17	16.0	0.0	0.0	152	84.0	4.2
R108	RZM R008 (Ital.gp.)	10724	13562	45.92	14.8	0.0	0.3	150	82.3	2.8
N152	NR-RZM 0204-2	7182	9145	36.89	12.3	0.0	0.0	145	80.2	6.2
S^f,MM,A:aa populations										
1915	RZM 0915	12667	14835	49.38	15.0	0.0	1.0	146	83.8	2.3
1913	RZM 0913	11779	14334	48.30	14.9	0.0	0.0	147	82.7	3.7
1914	RZM 0914	10540	12235	43.30	14.1	0.0	0.0	143	81.5	2.8
1905	BYR 9905	9405	10298	38.50	13.4	0.0	0.0	152	81.4	2.4
Mean		11138.9	13080.7	44.12	14.8	0.1	0.2	153.3	83.1	3.2
LSD (.05)		1135.0	1605.0	4.79	0.8	0.4	0.8	8.2	3.1	0.8
C.V. (%)		12.7	12.7	11.02	4.8	657.4	495.1	6.7	3.3	18.4
F value - varieties		19.4**	19.4**	14.10**	25.6**	8.9**	1.1NS	4.5**	3.3**	32.2**
F value - virus trtmt		1036.4**	1036.4**	560.77**	67.1**	0.7NS	0.7NS	0.0NS	13.4*	514.1**
F value - var. x virus		2.9**	2.9**	3.35**	1.6*	0.8NS	0.9NS	1.6*	1.3NS	1.2NS

[1]Test 1892 was grown in Block 3 near test 1192. See 1192. Because of a later planting date than 1192, 1892 appeared to have been more affected by rhizomania. Curly top infection occurred at a younger plant age and was more severe on highly susceptible entries. The virus yellows treatments remained visually distinct until late summer, then blurred and became nondistinct by harvest. Black aphids required periodic control.
[2]Variety means over both virus treatments.
[4]Variety means for noninoculated treatment.
[6]Also see tests 2692 and 1192 for common varieties. R128 = F_2(C37*3 x PI206407). Y131-43,-89 = C31-43,-89 released in 1991. R176-43,-89 = C31-43,-89 x R076 where R076 = C31R_z. R122Y2 = Cycle 2 VYS F_3 (Y54 x B.maritima lines). R107 = F_2(popn-747aa x Italian R05). R108 = F_2(popn-913$R_z$aa x Italian R06). N152 = B_1F_2(CTR*2 x B883) and segregates for resistance to cyst nematode. Z120,Z122,Z124 = F_2(popn-912$R_z$aa x 2N-Polish-Z). SP7622-0 = highly VYS check. 768 = VYS check. 6625 = VYS, high % sugar hybrid check.

TEST 1892. BYV INOCULATED EVALUATION OF MULTIGERM LINES, SALINAS, CA., 1992

32 entries x 2 virus trtmts x 6 reps, Split-block
1-row plots, 20 ft. long, 24 blocks

Planted: February 25, 1992
Harvested: October 21, 1992
BYV/BWYV Inoc.: May 6,1992

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[7] Rating	PM Mean
Checks										
U86-37	Inc. C37 (86443)	9213	21.4	32.97	16.9	14.0	5.1	81.4	2.5	6.4
R128	RZM 0271-# (C37*3 x PI07)	8034	29.1	29.26	25.4	13.7	4.5	81.4	3.4	5.6
6625	Beta 0011-1 (%S,susc.ch.)	6959	45.6	23.90	44.5	14.5	1.8	82.1	5.5	6.2
768	Inc. 868 (US 75)	4930	43.5	22.47	39.0	11.1	5.6	79.3	4.5	6.7
SP7622-0	Inc. SP22-O (L80466)	3170	65.9	14.81	58.1	10.9	17.6	79.1	6.5	5.7
C31 lines										
R176-89	Y931-89xR076 (C31-89R_Z)	12903	12.8	43.10	13.9	14.9	-0.9	81.5	2.4	4.4
R176-43	Y931-43xR076 (C31-43R_Z)	12046	21.2	40.91	17.2	14.7	4.7	84.2	2.4	4.8
Y131-43	BYR Y931-89 (C31-43)	11391	14.8	39.41	10.7	14.4	4.3	84.2	2.8	3.8
Y931-43	Inc. Y731-43	11076	22.2	38.22	18.8	14.5	4.4	83.0	3.1	4.3
Y931-89	Inc. Y731-89	10982	20.3	37.48	16.6	14.6	4.4	83.4	1.8	4.8
Y131-89	BYR Y931-89 (C31-89)	10745	15.5	36.82	12.1	14.6	3.7	81.5	2.1	4.6
F86-31/6	Inc. C31/6 (86263)	10349	13.2	37.24	11.4	13.9	2.5	84.1	2.4	4.4
VY and/or RZM resistant lines										
Y139	BYR Y939 (C39)	12006	14.7	37.59	13.3	15.9	1.3	84.7	2.9	2.3
R139C7	RZM R039C6 (C39R)	11056	24.9	38.27	20.2	14.4	5.8	82.4	3.1	2.2
R080	RZM R980 (C54R_Z)	10295	31.3	35.48	29.1	14.5	3.0	82.4	3.6	5.3
R122Y2	BYR R922Y (B.m. x Y54)	10078	31.6	36.85	24.3	13.7	9.5	77.2	2.9	4.5
Y141	BYR Y941 (C91)	9952	24.5	33.39	25.3	14.9	-1.3	82.0	2.9	2.2
Y054	BYR-ER-PMR Y854 (C54)	9670	25.7	34.42	20.4	14.1	6.4	81.5	3.5	3.9
Y148	BYR Y948 (C93)	9438	28.0	30.96	25.8	15.2	3.1	84.2	3.3	4.8
Y147	BYR Y947 (C47)	9229	37.0	31.27	32.9	14.8	6.0	82.5	3.7	3.9
Y156	BYR Y956	8846	29.9	32.48	28.9	13.6	1.4	82.5	3.8	3.9
R147C7	RZM R047C6 (C47R)	8271	39.1	30.92	31.5	13.4	11.0	82.1	3.8	5.6

TEST 1892. BYV INOCULATED EVALUATION OF MULTIGERM LINES, SALINAS, CA., 1992 (cont.)

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[7] Rating	PM Mean
RZM resistant lines										
Z120	RZM Z010H12 [F_2($R_z$aaxP-C)]	8814	36.3	29.50	31.7	14.9	6.7	80.8	4.5	5.9
R107	RZM R007 (Ital.gp.)	8364	39.8	30.23	34.0	13.8	8.2	80.9	4.6	6.4
Z124	RZM Z014H12 [F_2($R_z$aaxP-4)]	8332	40.1	27.86	37.2	14.9	4.6	82.4	4.0	5.5
Z122	RZM Z012H12 [F_2($R_z$aaxP-2)]	7972	42.9	26.66	41.4	14.9	2.4	82.0	4.5	5.0
R108	RZM R008 (Ital.gp.)	7886	41.8	29.43	35.9	13.4	9.4	79.9	4.9	4.7
N152	NR-RZM 0204-2	5218	42.9	22.71	38.4	11.5	6.8	77.6	4.1	7.3
S^f,MM,A:aa populations										
1915	RZM 0915	10500	29.2	36.97	25.1	14.2	5.7	80.7	3.2	4.2
1913	RZM 0913	9223	35.7	32.60	32.5	14.1	4.8	80.8	3.2	4.9
1914	RZM 0914	8844	27.7	32.61	24.7	13.5	4.3	83.5	3.6	3.8
1905	BYR 9905	8512	17.3	32.13	16.5	13.3	1.0	82.4	2.9	4.1
Mean		9197.1		32.47		14.0		81.8	3.5	4.8
LSD (.05)		1605.0		4.79		0.8		3.1	0.6	0.8
C.V. (%)		12.7		11.02		4.8		3.3	15.5	18.4
F value - varieties		19.4**		14.10**		25.6**		3.3**	21.1**	32.2**
F value - virus trtmt.		1036.4**		560.77**		67.1**		13.4*	---	514.1**
F value - var. x virus		2.9**		3.35**		1.6*		1.3NS	---	1.2NS

[3]Mean score for powdery mildew scored 7/31, 8/7, 8/19 where 9 = highly susceptible. PM was controlled through most of summer with Bayleton.

[7]Mean virus yellows scores from 6/9/92, 6/16/92, 6/29/92 & 7/6/92. Scored from 0 to 9 (100% of matured leaf canopy yellowed).

TEST 1692. NONINOCULATED BYV EVALUATION OF MULTIGERM PROGENY LINES, SALINAS, CA., 1992

24 entries x 2 virus trtmts x 6 reps, Split-block
1-row plots, 20 ft. long, 24 blocks

Planted: February 25, 1992
Harvested: October 21, 1992
Not BYV/BWYV Inoculated

Variety	Description	Acre Yield Sugar[5] lbs	Acre Yield Sugar[6] lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[5] %	Beets/ 100'[5] No.	RJAP %	PM Mean
Checks									
Y131-43	BYR Y931-43 (C31-43)	13910	15448	49.97	15.45	0.3	149	86.2	3.1
1913	RZM 0913	12146	14455	47.16	15.30	0.9	145	82.5	3.6
1915	RZM 0915	12424	13937	46.21	15.12	0.0	140	80.9	2.5
768	Inc. 868 (US 75)	8051	9940	38.61	12.90	0.3	153	79.1	6.4
1st progeny set from popns-907, -908, -909[1]									
1907-14	RZM 9907-14	10272	12610	39.81	15.87	0.0	153	82.8	3.5
1908- 7	RZM 9908- 7	10112	12530	43.03	14.57	0.0	144	80.8	4.7
1909-13	RZM 9909-13	8360	9887	35.50	13.92	0.6	140	78.5	7.0
2nd progeny set from popn-909[2]									
0909-37	Inc. 8909A-37	13174	15626	51.51	15.15	0.0	150	83.6	1.8
0909-34	Inc. 8909A-34	12250	13994	45.12	15.50	0.0	146	81.8	1.9
0909- 7	Inc. 8909A- 7	11239	12379	40.25	15.37	0.0	147	81.6	3.6
3rd progeny set from popns-911, -912, -913[3]									
1911-14	Inc. 9911-14	12116	14808	47.88	15.47	0.0	150	81.2	4.0
1911- 4	Inc. 9911- 4	13184	14703	45.73	16.05	0.0	147	82.1	2.3
1911-12	Inc. 9911-12	12851	14353	45.42	15.80	0.0	145	81.2	3.2
1911-50	Inc. 9911-50	11989	14336	46.27	15.47	0.0	148	83.0	2.6
1912- 3	Inc. 9912- 3	11597	14323	49.10	14.58	0.0	154	82.9	5.3
1912-11	Inc. 9912-11	12201	14269	46.34	15.42	0.0	147	82.0	4.7
1913-18	Inc. 9911H49-18	12538	14139	46.66	15.17	0.0	151	81.8	2.9
1913- 5	Inc. 9911H49- 5	11835	13985	46.48	15.05	0.3	149	83.5	2.2
1913-22	Inc. 9911H49-22	11621	13936	45.43	15.32	0.0	140	83.6	2.5
1913-25	Inc. 9911H49-25	11667	13841	45.41	15.23	0.0	150	82.4	2.7

TEST 1692. NONINOCULATED BYV EVALUATION OF MULTIGERM PROGENY LINES, SALINAS, CA., 1992[1] (cont.)

Variety	Description	Acre Yield Sugar[5] lbs	Acre Yield Sugar[6] lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[5] %	Beets/ 100'[5] No.	RJAP %	PM Mean
4th progeny set from popns-911, -913, -915[4]									
0913- 9	9911H49aa-9 x 9911H49	13751	16320	52.84	15.43	0.0	138	81.0	3.2
0911-24	9911aa-24 x 9911H49	13168	15698	48.86	16.08	0.0	150	82.3	4.7
0915- 7	9903aa-7 x 9911H49	12978	15263	48.58	15.72	0.0	147	83.4	3.2
0915- 4	9903aa-4 x 9911H49	13314	14991	49.84	15.07	0.0	147	82.7	3.4
Mean		11947.9	13990.6	45.92	15.21	0.1	146.9	82.1	3.5
LSD (.05)		1051.0	1486.0	4.85	0.60	0.4	11.6	2.6	1.0
C.V. (%)		10.9	10.9	10.73	3.52	567.3	9.8	2.7	21.2
F value - varieties		15.7**	15.7**	10.15**	16.28**	2.0**	1.1NS	3.8**	27.3**
F value - virus trtmt		91.7**	91.7**	98.15**	12.07*	2.1NS	0.2NS	0.8NS	142.6**
F value - var. x virus		1.5NS	1.5NS	1.57*	1.74*	1.1NS	0.8NS	1.7*	1.2NS

[1]Increase of S_1 families. Selected on basis of 1988 progeny test S_1aa x popn-767.
[2]Increases of seed from individual unprotected Aa plants of popn-909. Progeny families could be either S_1 or HS or mixed. Families tests in SJV in 1989 and selected families increased in 1990 and crossed to C309H3.
[3]Increases of half-sib families from 1989 Spence seed plots, 1911-4,-12,-14,-50 from 8911aa x A. 1912-3,-11 from RZM mother roots of popns-908,-909,-910,-911aa x A. 1913-5, -18, -22, -25 from popn-903aa x 8911. HS families progeny tested at Brawley and at Salinas under bolting and BYV conditions. Selected families increased in 1991 and crossed to C309H3.
[4]0911-24, 0913-9, 0915-4, and 0915-7 are half-sib families produced in 1990 at Spence. Half-sibs were progeny tested in 1991 at Brawley and Salinas under BYV. This test is from remnant HS seed. These lines were selected based upon: 0911-24 was ranked first for GS and %S at Brawley. 0915-4 was ranked first for GS and 7th for %S at Salinas with a low BYV score. 0913-9 ranked 3rd for GS and 17th for %S with low BYV and PM scores. 0915-7 ranked 6th for GS and 3rd for %S with a low BYV score. All lines were resistant to bolting at Brawley.
[5]Variety means over both virus treatments.
[6]Variety means for noninoculated treatment.

TEST 1692. BYV INOCULATED EVALUATION OF MULTIGERM PROGENY LINES, SALINAS, CA., 1992

24 entries x 2 virus trtmts x 6 reps, Split-block
1-row plots, 20 ft. long, 24 blocks

Planted: February 25, 1992
Harvested: October 21, 1992
BYV/BWYV Inoc.: May 6, 1992

Variety	Description	Sugar Yield		Beets Yield		Sucrose		RJAP	Mean Yellows[7]	PM
		Inoc.	Loss	Inoc.	Loss	Inoc.	Loss			
		Lbs/A	%	Tons/A	%	%	%	%	Rating	Mean
Checks										
Y131-43	BYR Y931-43 (C31-43)	12372	19.9	40.27	19.4	15.38	0.4	83.9	3.3	3.6
1915	RZM 0915	10911	21.7	36.62	20.8	14.90	1.4	81.6	4.1	4.1
1913	RZM 0913	9838	31.9	33.48	29.0	14.70	3.9	81.4	4.0	5.3
768	Inc. 868 (US 75)	6161	38.0	24.69	36.0	12.43	3.6	80.7	5.1	7.7
1st progeny set from popns-907, -908, -909										
1907-14	RZM 9907-14	7934	37.1	26.67	33.0	14.85	6.4	81.8	3.6	5.5
1908- 7	RZM 9908- 7	7694	38.6	27.75	35.5	13.88	4.7	80.2	4.0	6.1
1909-13	RZM 9909-13	6833	30.9	24.02	32.3	14.23	-2.3	81.6	5.6	7.7
2nd progeny set from popn-909										
0909-37	Inc. 8909A-37	10723	32.0	35.39	31.3	15.15	0.0	84.2	4.1	2.3
0909-34	Inc. 8909A-34	10505	24.9	34.55	23.4	15.22	1.8	83.5	4.1	3.6
0909- 7	Inc. 8909A- 7	10099	18.4	34.77	13.6	14.52	5.5	81.9	4.5	5.2
3rd progeny set from popns-911, -912, -913										
1911- 4	Inc. 9911- 4	11665	20.7	38.49	15.8	15.15	5.6	79.5	3.5	4.2
1911-12	Inc. 9911-12	11350	20.9	38.29	15.7	14.82	6.2	81.1	3.7	4.6
1913-18	Inc. 9911H49-18	10937	22.6	36.82	21.1	14.85	2.1	82.9	3.8	3.3
1912-11	Inc. 9912-11	10132	29.0	33.45	27.8	15.15	1.7	83.4	3.8	5.7
1913- 5	Inc. 9911H49- 5	9685	30.7	33.67	27.6	14.38	4.4	82.7	4.3	4.4

TEST 1692. BYV INOCULATED EVALUATION OF MULTIGERM PROGENY LINES, SALINAS, CA., 1992

(cont.)

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[7] Rating	PM Mean
3rd progeny set from popns-911, -912, -913 (cont.)										
1911-50	Inc. 9911-50	9642	32.7	32.49	29.8	14.83	4.1	80.8	4.3	3.5
1913-25	Inc. 9911H49-25	9492	31.4	31.71	30.2	14.98	1.6	81.4	3.8	3.9
1911-14	Inc. 9911-14	9423	36.4	32.06	33.0	14.70	5.0	79.4	3.5	5.4
1913-22	Inc. 9911H49-22	9307	33.2	31.85	29.9	14.62	4.6	82.3	3.2	2.7
1912- 3	Inc. 9912- 3	8872	38.1	31.01	36.8	14.30	1.9	80.7	4.5	6.0
4th progeny set from popns-911, -913, -915										
0915- 4	9903aa-4 x 9911H49	11637	22.4	38.40	23.0	15.13	-0.4	82.7	3.6	5.1
0913- 9	9911H49aa-9x9911H49	11183	31.5	36.80	30.4	15.20	1.5	83.1	3.3	3.9
0915- 7	9903aa-7 x 9911H49	10693	29.9	36.68	24.5	14.60	7.1	82.8	3.8	4.6
0911-24	9911aa-24 x 9911H49	10638	32.2	35.68	27.0	14.87	7.6	78.8	3.9	6.4
Mean		9905.2		33.57		14.70		81.8	4.0	4.8
LSD (.05)		1486.0		4.85		0.60		2.6	0.5	1.0
C.V. (%)		10.9		10.73		3.52		2.7	12.1	21.2
F value - varieties		15.7**		10.15**		16.28**		3.8**	8.1**	27.3**
F value - virus trtmt.		91.7**		98.15**		12.07*		0.8NS	---	142.6**
F value - var. x virus		1.5NS		1.57*		1.74*		1.7*	---	1.2NS

[7]Mean virus yellows scores from 6/9/92, 6/16/92, 6/29/92 & 7/6/92. Scored from 0 to 9 (100% of matured leaf canopy yellowed).

TEST 1992. NONINOCULATED BYV EVALUATION OF HYBRIDS, SALINAS, CA., 1992

32 entries x 2 virus trtmts x 6 reps, Split-block
1-row plots, 20 ft. long, 24 blocks

Planted: February 25, 1992
Harvested: October 19, 1992
Not BYV/BWYV Inoculated

Variety	Description	Acre Yield Sugar[2] lbs	Acre Yield Sugar[6] lbs	Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	PM Mean
Checks									
Y931SH89	88-790-68CMSxY731(C31/6)	10949	11850	43.54	13.6	0.3	155	84.7	2.4
4757	Beta (1/6/89)	10825	13037	47.88	13.6	0.0	167	84.8	2.1
HH 66	L663302	8430	9639	39.83	12.1	0.8	167	82.2	3.1
US H11	L113401	8258	9415	39.84	11.8	0.3	163	82.3	4.6
6625	Beta 0011-1(%S,susc.ch.)	7637	9517	34.85	13.7	0.5	166	84.3	3.8
VYR OP lines x 790-68H26									
Y039H18	88-790-68H26xY939(C39)	11315	12543	42.42	14.8	0.0	159	85.7	3.0
Y931SH18	88-790-68H26xY731(C31/6)	10606	12168	44.73	13.6	0.5	159	82.8	3.2
Y047H18	88-790-68H26xY947(C47)	10584	11800	42.80	13.8	0.0	155	84.6	3.6
Y048H18	88-790-68H26xY948(C93)	10205	12114	43.10	14.0	0.0	154	84.4	3.6
Retest of Y854 half-sibs									
R080H20	87-309H3 x R980	10601	12291	43.40	14.1	0.3	157	82.6	4.8
Y054-38H20	87-309H3xY854-38	9078	10038	39.06	12.9	0.3	159	82.7	3.9
Retest of S_1-790 lines									
R080H30	C790-15aa x R980	13286	14731	50.95	14.5	0.0	152	85.9	1.4
R080H33	C790-54aa x R980	12350	14498	51.73	13.9	0.0	154	84.6	2.9
R080H29	C790- 6aa x R980	12070	13669	48.58	14.1	0.0	153	83.5	3.2
R080H89	88-790-68CMS x R980	11932	13553	48.14	14.1	0.6	148	83.5	2.7
R080H90	popn-790(C4)aa x R980	11895	13874	48.16	14.4	0.0	156	85.2	3.5
Popn-907, -908, -909 progenies (1st set)									
1907-14H20	87-309H3 x RZM 9907-14	11292	13590	44.50	15.3	0.0	154	85.3	5.4
1908- 7H20	87-309H3 x RZM 9908- 7	10299	11648	41.98	13.9	0.0	155	84.3	5.3
1909-13H20	87-309H3 x RZM 9909-13	10255	11842	43.60	13.6	0.0	165	81.5	6.1

TEST 1992. NONINOCULATED BYV EVALUATION OF HYBRIDS, SALINAS, CA., 1992

(cont.)

Variety	Description	Acre Yield Sugar[2] lbs	Acre Yield Sugar[6] lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	PM Mean
Popn-909 progenies (2nd set)									
0909-37H20	87-309H3 x 8909A-37	10050	11325	41.72	13.6	0.0	163	84.5	3.3
0909-34H20	87-309H3 x 8909A-34	10010	11597	41.57	13.9	0.0	160	84.5	3.4
0909- 7H20	87-309H3 x 8909A- 7	9975	12059	45.71	13.2	0.0	144	84.5	3.9
Popn-911, -912, 913 progenies (3rd set)									
1911- 4H20	87-309H3 x 9911- 4	11988	13903	45.22	15.4	0.3	154	84.2	4.1
1911-14H20	87-309H3 x 9911-14	11303	13450	45.24	14.9	0.0	146	84.1	4.6
1911-12H20	87-309H3 x 9911-12	11257	13331	46.65	14.4	0.3	153	84.0	3.9
1911-50H20	87-309H3 x 9911-50	10829	13042	45.92	14.2	0.0	154	83.9	4.1
1913-25H20	87-309H3 x 9911H49-25	10572	12274	44.73	13.7	0.3	147	83.9	4.1
1912-11H20	87-309H3 x 9912-11	10104	11999	43.76	13.7	0.8	161	81.3	4.6
1913- 5H20	87-309H3 x 9911H49- 5	9758	11591	42.70	13.5	0.0	155	83.4	4.4
1912- 3H20	87-309H3 x 9912- 3	9169	10691	43.40	12.3	0.0	148	81.9	5.0
Checks for popn-907,...,-913									
0913H89	88-790-68CMS x 9911H49	11121	12234	44.03	13.9	0.0	154	83.5	3.0
0913H20	87-309H3 x 9911H49	9865	11593	42.00	13.8	0.0	160	82.8	4.5
Mean		10558.3	12215.8	44.12	13.8	0.2	156.1	83.8	3.8
LSD (.05)		1019.0	1441.0	4.49	0.8	0.6	8.9	0.9	0.7
C.V. (%)		12.0	12.0	10.26	5.6	445.6	7.1	3.6	12.6
F value - varieties		11.2**	11.2**	7.39**	10.3**	1.4NS	3.6**	0.9NS	31.8**
F value - virus trtmt.		115.2**	115.2**	182.97**	5.9*	1.5NS	1.5NS	1.4NS	100.3**
F value - var. x virus		1.1NS	1.1NS	1.11NS	1.0NS	1.5*	0.9NS	0.9NS	1.5*

See Test 1892 for conditions. See 1292 & 1492 for variety descriptions and performance without yellows.

[2]Variety means over both virus treatments.
[6]Variety means for noninoculated treatment.

TEST 1992. BYV INOCULATED EVALUATION OF HYBRIDS, SALINAS, CA., 1992

32 entries x 2 virus trtmts x 6 reps, Split-block
1-row plots, 20 ft. long, 24 blocks

Planted: February 25, 1992
Harvested: October 19, 1992
BYV/BWYV Inoc.: May 6, 1992

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[7] Rating	PM Mean
Checks										
Y931SH89	88-790-68CMS x Y731 (C31/6)	10049	15.2	37.02	15.0	13.6	-0.1	83.8	2.8	4.4
4757	Beta (1/6/89)	8613	33.9	32.32	32.5	13.3	2.2	83.1	4.5	5.0
HH 66	L663302	7221	25.1	29.91	24.9	12.1	0.1	84.3	4.0	5.9
US H11	L113401	7102	24.6	29.60	25.7	12.0	-2.1	83.6	3.6	7.0
6625	Beta 0011-1(%S,susc.ch.)	5757	39.5	21.93	37.1	12.9	5.7	84.8	5.0	5.7
VYR OP lines x 790-68H26										
Y039H18	88-790-68H26 x Y939 (C39)	10088	19.6	35.98	15.2	14.0	5.2	83.5	3.4	4.9
Y047H18	88-790-68H26 x Y947 (C47)	9367	20.6	35.00	18.2	13.4	2.9	84.1	3.3	5.4
Y931SH18	88-790-68H26 x Y731 (C31/6)	9043	25.7	33.91	24.2	13.4	1.7	83.1	3.4	5.3
Y048H18	88-790-68H26 x Y948 (C93)	8297	31.5	30.59	29.0	13.6	3.3	82.6	3.5	6.2
Retest of Y854 half-sibs										
R080H20	87-309H3 x R980	8911	27.5	32.41	25.3	13.8	2.7	82.6	3.7	6.0
Y054-38H20	87-309H3 x Y854-38	8117	19.1	31.64	19.0	12.8	0.5	85.3	3.5	5.8
Retest of S_1-790 lines										
R080H30	C790-15aa x R980	11841	19.6	39.90	21.7	14.8	-2.3	83.9	3.1	3.1
R080H29	C790- 6aa x R980	10470	23.4	36.25	25.4	14.4	-2.4	85.9	3.3	4.8
R080H89	88-790-68CMS x R980	10311	23.9	36.17	24.9	14.3	-1.4	83.3	3.1	4.4
R080H33	C790-54aa x R980	10202	29.6	35.91	30.6	14.2	-1.8	84.8	3.1	4.4
R080H90	popn-790(C4)aa x R980	9915	28.5	36.19	24.9	13.7	5.1	83.4	3.4	4.9
Popn-907, -908, -909 progenies (1st set)										
1907-14H20	87-309H3 x RZM 9907-14	8994	33.8	31.39	29.5	14.3	6.1	83.1	3.8	7.2
1908- 7H20	87-309H3 x RZM 9908- 7	8950	23.2	33.53	20.1	13.3	3.9	82.8	4.2	6.7
1909-13H20	87-309H3 x RZM 9909-13	8668	26.8	31.08	28.7	13.9	-2.7	82.6	4.3	7.6

TEST 1992. BYV INOCULATED EVALUATION OF HYBRIDS, SALINAS, CA., 1992

(cont.)

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[7] Rating	PM Mean
Popn-909 progenies (2nd set)										
0909-37H20	87-309H3 x 8909A-37	8775	22.5	32.55	22.0	13.4	0.9	84.5	3.8	5.1
0909-34H20	87-309H3 x 8909A-34	8424	27.4	30.55	26.5	13.8	1.0	84.3	3.9	5.1
0909- 7H20	87-309H3 x 8909A- 7	7891	34.6	31.92	30.2	12.4	6.1	82.0	4.0	5.8
Popn-911, -912, 913 progenies (3rd set)										
1911- 4H20	87-309H3 x 9911- 4	10074	27.5	36.12	20.1	14.0	9.0	81.9	3.6	6.7
1911-12H20	87-309H3 x 9911-12	9183	31.1	33.88	27.4	13.6	5.6	81.0	3.7	6.2
1911-14H20	87-309H3 x 9911-14	9156	31.9	32.62	27.9	14.0	5.7	83.1	4.0	7.0
1913-25H20	87-309H3 x 9911H49-25	8870	27.7	33.37	25.4	13.0	5.1	82.4	4.1	6.0
1911-50H20	87-309H3 x 9911-50	8616	33.9	31.83	30.7	13.5	4.5	80.5	4.5	6.3
1912-11H20	87-309H3 x 9912-11	8208	31.6	31.47	28.1	13.1	4.3	83.4	3.9	6.3
1913- 5H20	87-309H3 x 9911H49- 5	7925	31.6	30.60	28.3	12.9	4.4	84.3	4.3	6.1
1912- 3H20	87-309H3 x 9912- 3	7646	28.5	31.75	26.9	12.0	2.3	82.0	4.5	6.9
Checks for popn-907,...,-913										
0913H89	88-790-68CMS x 9911H49	10009	18.2	36.65	16.8	13.6	1.7	83.8	3.4	4.9
0913H20	87-309H3 x 9911H49	8137	29.8	31.43	25.2	12.9	6.0	83.6	4.0	6.6
Mean		8900.9		32.98		13.4		83.4	3.8	5.7
LSD (.05)		1441.0		4.49		0.8		0.9	0.6	0.7
C.V. (%)		12.0		10.26		5.6		3.6	13.8	12.6
F value - variety		11.2**		7.39**		10.3**		0.9	5.6**	31.8**
F value - virus trtmt.		115.2**		182.97**		5.9*		1.4NS	---	100.3**
F value - var. x virus		1.1NS		1.11NS		1.0NS		0.9	---	1.5*

[7]Mean virus yellows scores from 6/9/92, 6/16/92, 6/29/92 & 7/6/92. Scored from 0 to 9 (100% of matured leaf canopy yellowed).

TEST B192. RETEST OF EXPERIMENTAL HYBRIDS, BRAWLEY, CA, 1991-92 (B192)

32 entries x 8 replications, RCB
1-row plots, 24 ft. long (16 blocks)

Planted: September 24, 1991
Harvested: May 18, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/100' No.	Clean Beets %	NO3-N Mean
R080H30	8790-15aa x R980	11570	35.86	16.14	0.3	0.0	131	95.5	42.94
R080H38	89-312CMS x R980	10820	35.09	15.40	0.4	0.0	118	95.9	49.00
0913H37	9807HO x 9911H49	10740	34.99	15.35	0.0	0.0	136	95.0	45.75
R080H113	9867H67aa x R980	10530	33.69	15.63	1.6	0.4	139	94.6	40.75
R080H133	9864aa x R980	10530	34.06	15.44	0.0	0.0	147	96.2	52.25
0913H132	9865aa x 9911H49	10520	33.54	15.72	1.0	0.0	143	95.5	50.00
R080H39	89-762-17CMS x R980	10520	35.75	14.67	0.3	0.0	143	94.7	52.75
R080H23	87-309H37 x R980	10430	33.58	15.55	1.2	0.8	134	95.1	34.94
R080H34	8790-55aa x R980	10390	31.57	16.43	0.0	0.0	126	94.5	36.25
0913H39	89-762-17CMS x 9911H49	10360	33.44	15.50	0.0	0.0	139	94.2	23.75
R080H37	9807HO x R980	10310	33.26	15.51	0.4	0.0	117	95.2	52.75
R080H33	8790-54aa x R980	10230	32.03	15.94	0.3	0.0	146	94.6	32.31
R080H89	88-790-68CMS x R980	10180	31.14	16.37	2.1	0.0	119	94.8	50.56
R080H40	89-313CMS x R980	10050	31.49	15.90	0.4	0.0	119	94.7	59.88
R080H112	9866H80aa x R980	10030	32.86	15.23	1.3	0.0	136	95.9	86.88
R080H132	9865aa x R980	9921	31.57	15.71	0.3	0.0	136	95.3	51.75
Y039H132	9865aa x Y939	9907	30.88	16.02	0.3	0.0	142	95.5	69.94
R080H29	8790-6aa x R980	9887	30.51	16.23	0.4	0.0	134	96.1	64.25
Y054-23H20	87-309H3 x Y854-23	9852	30.09	16.37	0.0	0.3	147	94.5	18.50
R080H26	87-309CMS x R980	9798	31.38	15.58	2.6	0.6	148	94.9	57.81
Y054-38H20	87-309H3 x Y854-38	9775	30.09	16.22	0.0	0.0	146	95.7	34.19
HH 41	L 41138	9759	31.39	15.50	0.0	0.0	152	95.7	67.38
0913H113	9867H67aa x 9911H49	9758	31.27	15.59	0.0	0.0	144	95.3	45.31
R080H111	9859H6aa x R980	9547	31.43	15.21	0.0	0.0	139	96.2	71.19
Z012H20	87-309H3 x Polish-2	9486	29.76	15.90	0.3	0.0	154	95.3	34.50
R070H20	87-309H3 x R971-R980	9407	29.89	15.75	0.9	0.0	142	95.3	36.75
R047C5H20	87-309H3 x R947C5	9165	29.14	15.72	0.3	0.0	150	94.6	37.94
Z010H20	87-309H3 x P1-P7	9121	26.59	17.17	0.0	0.4	134	95.2	41.75

TEST B192. RETEST OF EXPERIMENTAL HYBRIDS, BRAWLEY, CA, 1991-92 (B192)

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/100' No.	Clean Beets %	NO3-N Mean
R047C5H132	9865aa x R947C5	9039	27.65	16.34	1.4	0.0	138	95.7	37.59
R080H20	87-309H3 x R980	9024	28.98	15.57	0.0	0.0	141	94.5	57.94
Y054-85H20	87-309H3 x Y854-85	8934	26.79	16.61	0.0	0.0	145	95.3	19.50
US H11	L 786442	8189	28.14	14.52	0.0	0.0	136	93.7	101.60
Mean		9930.9	31.50	15.78	0.5	0.1	138.2	95.2	48.71
LSD (.05)		893.9	2.44	0.62	1.3	0.5	12.8	1.3	39.93
C.V. (%)		9.1	7.86	4.00	264.3	688.4	9.4	1.4	83.22
F value		4.4**	7.85**	5.89**	2.1**	1.1NS	4.5**	1.6NS	1.59NS

Entries in this test are hybrids that performed best in 1991 tests in Brawley

TEST B392. HYBRID EVALUATION OF SELECTED PROGENY LINES, BRAWLEY, CA, 1991-92

16 entries x 8 replications, RCB (equalized)
1-row plots, 24 ft. long (16 blocks)

Planted: September 24, 1991
Harvested: May 18, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/100' No.	Clean Beets %	NO3-N Mean
1911-50H20	87-309H3 x 9911-50	10610	33.67	15.76	3.1	149	95.7	120.7
1913-18H20	87-309H3 x 9911H49-18	10210	33.56	15.24	0.0	133	93.9	127.9
HH 41	L41138	10170	33.64	15.11	0.0	151	95.4	181.6
0906-4H20	87-309H3 x 8906A-4	10130	33.61	15.05	0.0	137	94.9	168.4
1912-11H20	87-309H3 x 9912-11	9934	33.46	14.84	0.0	147	93.4	127.9
0909-37H20	87-309H3 x 8909-37	9714	32.03	15.19	1.4	147	96.1	134.1
1913-25H20	87-309H3 x 9911H49-25	9673	31.34	15.43	0.0	130	92.5	117.9
1911-14H20	87-309H3 x 9911-14	9571	30.73	15.56	0.0	142	94.2	114.6
1911-12H20	87-309H3 x 9911-12	9462	29.96	15.81	0.0	146	94.7	83.6
1913-22H20	87-309H3 x 9911H49-22	9435	30.66	15.36	0.0	131	94.6	116.9
0913H20	87-309H3 x 9911H49	9425	30.79	15.27	0.0	144	94.3	131.8
1911-4H20	87-309H3 x 9911-4	9412	29.98	15.74	0.0	126	93.6	86.3
1913-5H20	87-309H3 x 9911H49-5	9388	30.30	15.49	0.0	134	93.2	102.4
1908-7H20	87-309H3 x 9908-7	8831	29.35	15.08	0.0	143	95.0	112.9
1912-3H20	87-309H3 x 9912-3	8782	29.43	14.93	0.3	146	93.7	118.3
US H11	L786442	8667	29.54	14.66	0.0	135	92.3	163.2
Mean		9587.7	31.38	15.28	0.3	140.1	94.2	125.5
LSD (.05)		703.8	1.96	0.56	1.1	10.5	1.4	54.9
C.V. (%)		7.4	6.30	3.72	348.8	7.5	1.5	44.2
F value		4.7**	5.80**	2.81**	4.9**	4.3**	5.0**	1.9*

9911-4 thru 9911H49-25 are half-sib lines selected and increased after 1990 progeny tests at Brawley (64 entries) and BYV infected and nonbolting progeny tests (100 entries) at Salinas. Hybrids with 9908-7 and 8906A-4 & 8909-37 are retests of selected progeny lines based upon 1990 and 1991 test-cross hybrids at Brawley.

TEST B492. EVALUATION OF O.P. GERMPLASM, BRAWLEY, CA, 1991-92

16 entries x 8 replications, RCB (equalized)
1-row plots, 24 ft. long (16 blocks)

Planted: September 24, 1991
Harvested: May 18, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/100' No.	Clean Beets %	NO3-N Mean
0915-21	9903aa-21 x A	10780	34.78	15.54	0.0	141	94.0	89.1
HH 41	L41138	10580	34.91	15.16	0.3	155	95.1	157.9
0911 (Sp)	9911(Iso)aa x A	10580	34.05	15.55	0.0	134	94.9	134.6
R139C7	RZM R039C6	10560	34.20	15.46	9.7	140	96.8	112.4
0911-7	9911aa-7 x A	10500	35.31	14.83	0.7	146	94.5	154.0
R070	Inc. R971-R980	10310	34.69	14.95	1.8	136	95.2	190.4
Y931	Inc. Y731 (Iso)	10220	32.11	15.94	0.4	137	97.2	79.6
Y147	BYV Y947	10000	30.83	16.23	1.3	144	95.8	66.1
0913 (Sp)	9911H49aa x A	9996	32.19	15.51	1.6	137	95.4	148.4
R080 (Sp)	Inc. R980	9930	32.27	15.40	0.3	133	96.1	125.3
R122Y2	BYV R922Y,S; R918	9919	33.61	14.80	8.7	154	92.5	150.6
Y139	BYV Y939	9859	29.70	16.61	1.0	143	97.2	115.8
Y954 (Sp)	Inc. Y854 (Iso)	9537	29.89	15.94	0.8	137	95.1	76.4
US H11	L786442	9156	31.59	14.50	0.6	136	93.3	167.0
R147C7	RZM R047C6	9117	28.55	16.04	0.7	146	96.1	102.6
Z010	Inc. Polish 1-7	8405	23.24	18.06	3.5	128	93.7	76.4
Mean		9965.4	32.00	15.66	2.0	140.5	95.2	121.7
LSD (.05)		867.5	2.26	0.82	2.4	11.7	1.5	73.5
C.V. (%)		8.8	7.14	5.29	121.3	8.4	1.6	61.0
F value		4.3**	14.94**	8.55**	12.3**	3.1NS	6.8**	2.1**

TEST B692.[1,2,3] EVALUATION OF PLANTING DATE X HARVEST DATE X VARIETY ON PERFORMANCE AND EFFECTS OF RHIZOMANIA
BRAWLEY, 1991-92

8 entries x 2 planting dates x 2 harvest dates x 6 replications[4]
1-row plots, 14 ft. long

Planted: Sept. 24, & Oct. 28, 1991
Harvested: May 16, & June 30, 1992

	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Stand Count[6] Beets/100' No.	Harvest Count[7] Beets/100' No.	Clean Beets %	Root Rot[8] %	NO3-N ppm
Treatment[5] Varieties								
(5) R039C5H113	7678	30.10	12.69	169	150	94.2	12.7	159.3
(4) Rima	7246	26.94	13.46	177	150	94.1	15.9	215.3
(3) Rhizosen	7156	28.51	12.53	172	136	94.3	23.7	152.1
(7) R047C5H113	6845	28.04	12.19	170	146	93.7	16.9	152.0
(6) Y039H20	6171	26.15	12.15	170	151	93.8	14.0	139.5
(8) Y047H20	5777	23.89	12.05	173	144	93.9	20.1	118.9
(2) HH 41	5359	23.55	11.25	183	139	93.0	28.0	119.4
(1) US H11	3761	17.72	10.45	181	119	92.3	39.7	141.8
Planting Date								
(1) 09/24/91	7276	29.25	12.35	186	153	93.4	20.7	116.9
(2) 10/28/91	5222	21.73	11.84	162	131	93.9	22.0	182.7
Harvest Date								
(1) 05/16/92	6854	25.78	13.21	169	147	94.0	12.6	153.9
(2) 06/30/92	5644	25.20	10.99	179	137	93.3	30.1	145.7
Var x PD								
1 x 1	4725	22.28	11.39	201	133	92.2	39.2	112.5
1 x 2	2797	13.16	9.51	161	105	92.5	40.1	171.2
2 x 1	6083	26.96	12.75	191	151	93.3	26.7	83.5
2 x 2	4634	20.15	9.74	174	128	92.7	29.2	155.4
3 x 1	8053	32.05	13.31	187	145	94.2	24.3	128.8
3 x 2	6258	24.96	11.74	157	126	94.4	23.1	175.4
4 x 1	8340	30.21	14.28	191	159	93.1	17.0	163.0
4 x 2	6153	23.68	12.63	163	141	95.0	14.8	267.7
5 x 1	9187	35.10	13.45	177	163	93.9	9.5	134.3
5 x 2	6169	25.09	11.94	160	136	94.5	15.8	184.3
6 x 1	6962	28.00	13.47	183	162	93.7	14.0	118.1
6 x 2	5380	22.33	10.83	156	140	93.9	14.0	160.9
7 x 1	8138	32.65	13.73	178	153	92.9	16.9	107.4
7 x 2	5551	23.44	10.65	162	139	94.5	16.8	196.6
8 x 1	6720	26.72	13.27	181	155	93.8	17.9	87.8
8 x 2	4835	21.06	10.84	165	133	93.9	22.2	149.9

TEST B692.[1,2,3] EVALUATION OF PLANTING DATE X HARVEST DATE X VARIETY ON PERFORMANCE AND EFFECTS OF RHIZOMANIA
BRAWLEY, 1991-92

(cont.)

	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Stand Count Beets/100'[6] No.	Harvest Count Beets/100'[7] No.	Clean Beets %	Root Rot[8] %	NO3-N ppm
Treatment (cont.)								
Var x HD								
1 x 1	4489	19.58	11.39	173	139	92.6	19.0	160.0
1 x 2	3033	15.86	9.51	189	99	92.1	60.4	123.7
2 x 1	6753	26.48	12.75	181	158	93.8	12.8	123.8
2 x 2	3964	20.63	9.74	184	121	92.3	43.1	115.0
3 x 1	7922	29.75	13.31	168	140	94.5	16.2	156.9
3 x 2	6389	27.26	11.74	176	131	94.1	31.1	147.3
4 x 1	7446	26.06	14.28	179	152	94.0	14.0	218.4
4 x 2	7047	27.83	12.63	175	148	94.1	17.8	212.2
5 x 1	8115	30.13	13.45	159	146	94.6	8.7	174.1
5 x 2	7241	30.06	11.94	178	154	93.9	16.7	144.5
6 x 1	6735	25.04	13.57	159	149	94.3	5.8	132.6
6 x 2	5607	25.29	10.83	180	154	93.3	22.1	146.4
7 x 1	7457	27.04	13.73	167	145	94.2	13.1	142.3
7 x 2	6232	29.05	10.65	174	147	93.2	20.6	161.7
8 x 1	5917	22.13	13.27	167	148	94.2	11.3	122.8
8 x 2	5638	25.65	10.84	180	140	93.6	28.9	115.0
Grand Mean	6249	25.49	12.10	174	142	93.7	21.4	149.8
LSD (.05) - V	791	3.1	0.6	11.2	12.0	1.0	6.8	26.7
LSD (.05) - PD	**	**	**	**	**	*	NS	**
LSD (.05) - HD	**	NS	**	**	**	**	**	NS
LSD (.05) - VxPD	1118	4.3	0.9	15.9	17.0	1.4	9.6	37.8
LSD (.05) - VxHD	1157	4.5	0.9	15.1	18.8	1.5	8.1	36.7
C.V. (%) - VxPxH	22.8	21.72	9.39	10.7	16.3	1.9	46.7	30.2
F value - V	20.7**	12.7**	17.87**	1.8NS	6.3**	3.6**	14.1**	10.2**
F value - PD	107.1**	96.1**	11.26**	71.6**	52.0**	4.3*	0.6NS	96.2**
F value - V x PD	0.9NS	0.6NS	1.19NS	1.3NS	0.3NS	1.3NS	0.4NS	1.3NS
F value - HD	34.7**	0.5NS	183.98**	14.4**	9.2**	7.4**	147.2**	1.6NS
F value - V x HD	1.8NS	2.0NS	1.95NS	1.3NS	3.8**	0.5NS	9.7**	1.0NS
F value - PD x HD	0.8NS	0.3NS	3.17NS	3.2NS	2.7NS	0.4NS	19.0**	2.0NS
F value - VxPxH	0.4NS	0.6NS	0.51NS	1.1NS	0.7NS	2.0NS	1.1NS	1.3NS

[1] See Test B592 for performance in adjacent test under non-rhizomania conditions. Variety x treatment code 1 for planting and harvest dates would be comparable to test B592.

TEST B692.[1,2,3] EVALUATION OF PLANTING DATE X HARVEST DATE X VARIETY ON PERFORMANCE AND EFFECTS OF RHIZOMNIA BRAWLEY, 1991-92

(cont.)

[2] LIYV did not occur in these tests or to any significant degree in Imperial Valley in 1991-92.

[3] Rhizomania infestation was mild to moderate and somewhat variable from top to bottom of test. Root symptoms were generally mild at first harvest date. Root rot was severe in rhizomania susceptible varieties at second harvest date. Field area was in sugarbeet variety trials in 1990-91 ans very mild rhizomania detected. Soil samples proved positive for BNYVV. Cyst nematode infestation also occurs in this field plot area.

[4] RCB design for varieties and planting dates with harvest dates as a split-plot on varieties and planting dates. Planted September 24, 1991 and October 28, 1991. Harvested May 16, 1992 and June 30, 1992.

[5] See test B592 for hybrid descriptions. R939C5 = C39R; Y939 = C39 (selection for virus yellows resistance, not for rhizomania); R947C5 = C47R; Y947 - C47; 87-309H3 = C562CMS x C309 (susceptible to rhizomania); 9867H67 = population that segregates for resistance to rhizomania (R_Z).

[6] Stand count = counts made post thinning.

[7] Harvest count = root count in tare laboratory.

[8] % root rot = difference between stand count and harvest count plus number of rotted roots in tare sample. Completely rotted and desicated roots were not harvested. Actual number of rotted roots were not actually counted. Because essentially no rot occurred for May 16 harvest, this method to calculate % rot appears to over estimate rot ±12%. Some plant losses between thinning and harvest were apparently due to other causes.

Conclusions: Based upon a comparison of tests B592 and the comparable planting and harvest date treatments in test B692, rhizomania caused sugar yield losses that ranged from 6% for R039C5H113 to 31% for US H11. Per cent losses for US H11, HH41, Rhizosen, Rima, R039C5H113, Y039H20, R047C5H113, and Y047H20 were 31, 27, 14, 9, 6, 20, 14, and 28%, respectively for the May harvest date. Whereas there was relatively little root rot for the May 16 harvest, root rot was severe for the June 30 harvest and highly correlated to the degree of susceptibility to rhizomania. Under the conditions of late harvest (June 30), rhizomania essentially had stopped root growth, caused sugar to greatly decrease, and greatly increased the incidence of root rot. Rhizomania appears to have the potential to cause severe losses in the Imperial Valley. Every effort should be made to prevent its occurrence and spread.

TEST B592. PERFORMANCE OF HYBRIDS IN TEST B692, BRAWLEY, CA, 1991-92

8 entries x 8 replications, RCB
1-row plots, 24 ft. long (16 blocks)

Planted: September 24, 1991
Harvested: May 18, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/100' No.	Clean Beets %	NO3-N Mean
R039C5H113	9867H67aa x R939C5	10500	34.82	15.08	1.7	160	94.0	156.8
R047C5H113	9867H67aa x R947C5	10370	33.93	15.29	1.2	156	94.4	154.3
HH 41	L41138	10280	34.17	15.04	0.3	169	95.1	121.3
Rhizosen	L493302	10130	34.39	14.76	1.2	152	96.9	183.3
Y039H20	87-309H3 x Y939	10000	31.66	15.80	0.0	160	94.7	110.8
Y047H20	87-309H3 x Y947	9775	31.52	15.49	1.4	161	94.6	105.1
Rima	SES (rec'd)	9200	29.66	15.52	2.7	144	93.1	228.1
US H11	L786442	7876	28.43	13.85	0.0	163	92.2	209.9
Mean		9765.6	32.32	15.10	1.1	158.1	94.4	158.7
LSD (.05)		952.9	2.92	0.57	1.8	13.4	1.8	50.6
C.V. (%)		9.7	8.98	3.76	167.4	8.4	1.9	31.8
F value		6.7**	5.40**	9.00**	2.3*	2.6*	4.8**	6.6**

TEST B292. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA, 1991-92

32 entries x 8 replications, RCB
1-row plots, 24 ft. long

Planted:
Harvested: May 18, 1992

Code No.	Variety	Source	Acre Yield Sugar lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/100' No.	Clean Beets %	NO3-N ppm
A5-11	OBG6476	Betaseed	11260	37.77	14.91	0.8	136	94.7	148.7
-25	HM 3013	Hilleshog	11120	35.42	15.67	0.3	138	93.6	110.4
-32	R080H39	USDA *	11100	37.25	14.91	0.0	137	93.8	115.3
-09	H90543	Spreckels	10840	35.43	15.30	0.0	148	95.9	95.3
-04	9BG6346	Betaseed	10740	35.40	15.18	1.3	141	96.0	124.1
-19	OBG6392	Betaseed	10620	34.15	15.53	0.0	128	96.0	84.3
-22	H90547	Spreckels	10480	33.33	15.73	0.0	155	95.3	73.9
-01	HM 3104	Hilleshog	10440	35.42	14.72	1.9	145	95.8	145.1
-03	H89299	Spreckels	10390	35.48	14.63	0.0	149	94.0	148.1
-16	90C63-015	Holly	10270	35.02	14.68	0.0	146	95.2	146.0
-27	90-88C11-02	Holly	10130	33.44	15.16	2.4	152	95.6	146.7
-18	HH 41	Holly	10070	33.11	15.23	0.6	155	95.2	101.9
-02	90-1459-0189	Holly	10010	32.19	15.60	0.0	143	96.1	96.3
-30	HM 3005	Hilleshog	9944	33.01	15.07	0.0	142	93.2	115.1
-20	OBG6172	Betaseed	9843	31.64	15.55	0.0	147	92.9	87.3
-08	HH 77	Holly	9834	33.24	14.76	0.0	142	93.8	111.9
-13	HH 69	Holly	9834	33.51	14.67	0.0	143	95.6	142.8
-23	HM 3022	Hilleshog	9811	32.35	15.17	0.0	152	94.8	94.5
-06	88C 144-04	Holly	9798	33.13	14.75	0.0	146	95.5	140.8
-24	H90636	Spreckels	9791	33.15	14.76	0.0	146	95.0	114.5
-10	OBG6178	Betaseed	9725	31.90	15.24	0.0	157	93.7	98.7
-17	H90345	Spreckels	9559	30.09	15.84	0.9	150	94.1	96.8
-31	9BG6269	Betaseed	9524	28.76	16.58	0.0	132	93.8	80.6
-12	90C63-014	Holly	9521	31.42	15.11	0.0	143	94.7	143.9

* Filler from USDA. R080H39 = C762-17CMS x R980.

TEST B292. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA, 1991-92

(cont.)

Code No.	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/100' No.	Clean Beets %	NO3-N ppm
A5-28	OBG6173	Betaseed	9520	31.58	15.07	0.3	148	93.4	97.3
-14	90-88C11-09	Holly	9319	31.34	14.74	0.0	138	94.5	115.7
-07	4823	Betaseed	9220	31.00	14.85	1.6	142	92.3	124.4
-26	90C63-010	Holly	9220	30.59	15.07	0.0	141	94.2	122.9
-05	90C69-04	Holly	9179	32.27	14.23	0.0	135	93.0	140.8
-21	HH 66	Holly	9165	29.91	15.32	0.0	149	95.7	93.9
-29	HH 79	Holly	8971	29.40	15.25	0.0	137	92.9	75.8
-15	US H11	Check	8183	29.61	13.79	0.3	152	92.1	209.9
Mean			9919.	32.85	15.10	0.32	144.2	94.44	116.99
LSD (.05)			800.3	2.30	0.61	0.84	12.9	1.50	48.16
C.V. (%)			8.2	7.12	4.12	264.99	9.1	1.61	41.80
F value			5.7**	7.46**	5.40**	4.31**	2.2NS	4.62**	2.80**

TEST B292. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA, 1991-92

(cont.)

Variety	Sodium ppm	Potassium ppm	Amino Nitrogen ppm	Recov. Sugar lbs/acre	Recov. Sugar %	Recov. Sugar lbs/ton	Imp. Value	Known Sugar Loss lbs/acre
OBG6476	647	2539	857	9363	82.9	248	16750	1901
HM 3013	629	2061	872	9457	84.8	266	15640	1660
R080H39	584	2226	696	9509	85.7	256	14220	1587
H90543	784	2000	791	9215	84.9	260	15260	1626
9BG6346	647	1923	786	9191	85.6	260	14530	1545
0BG6392	690	1871	735	9181	86.4	268	14070	1434
H90547	673	2016	778	9006	85.9	270	14790	1475
HM 3104	661	1938	683	8984	86.0	254	13650	1451
H89299	711	2189	945	8601	82.5	242	16940	1787
90C63-015	647	1976	819	8693	84.5	249	14990	1579
90-88C11-02	818	1960	663	8720	86.0	261	14060	1411
HH 41	689	1993	763	8618	85.6	261	14640	1456
90-1459-0189	541	1876	676	8749	87.4	273	13000	1261
HM 3005	713	2126	856	8364	84.0	254	15940	1579
0BG6172	519	1921	700	8579	87.0	271	13260	1264
HH 77	454	2131	825	8372	84.7	251	14750	1463
HH 69	668	2084	819	8296	84.2	247	15330	1538
HM 3022	526	1844	822	8418	85.8	261	14260	1393
88C 144-04	613	2174	800	8313	84.3	250	15190	1485
H90636	700	1783	760	8384	85.6	253	14120	1407
0BG6178	581	1950	758	8373	86.0	263	14110	1352
H90345	707	1992	828	8179	85.4	271	15320	1380
9BG6269	541	1779	1001	8156	85.7	284	15840	1368
90C63-014	633	2022	857	8078	84.4	256	15410	1443

TEST B292. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA, 1991-92

(cont.)

Variety	Sodium ppm	Potassium ppm	Amino Nitrogen ppm	Recov. Sugar lbs/acre	Recov. Sugar %	Recov. Sugar lbs/ton	Imp. Value	Known Sugar Loss lbs/acre
0BG6173	562	1890	849	8138	85.2	257	14760	1383
90-88C11-09	666	2017	751	7950	85.3	252	14510	1369
4823	592	1938	909	7775	84.1	250	15550	1445
90C63-010	759	1997	818	7798	84.6	255	15420	1422
90C69-04	617	2056	902	7642	83.0	237	15870	1537
HH 66	579	1830	819	7856	85.9	263	14380	1309
HH 79	457	1873	833	7720	86.1	263	14200	1251
US H11	623	2050	1040	6664	81.1	224	17180	1518
Mean	632.2	2000.7	812.8	8448.0	85.0	257.1	14936.0	1471.2
LSD (.05)	188.1	312.4	160.8	807.8	2.9	16.5	2578.0	275.6
C.V. (%)	30.2	15.9	20.1	9.7	3.5	6.5	17.5	19.0
F value	1.6NS	1.8*	2.3**	4.5**	1.6NS	3.8**	1.1NS	2.1**

TEST RZM 792. EVALUATION OF LINES TO RHIZOMANIA, SALINAS, CA., 1992

32 entries x 4 replications, RCB
1-row plots, 18 ft. long

Planted: June 5, 1992
Harvested: November 19, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	Beets/ 100' No.	Bolting %	Powdery Mildew Score	Virus Yellows Score	CLS Score
Checks										
US H11	L113401	1294	7.52	8.5	66.5	183	0.0	5.0	6.0	5.0
Rhizosen	L493302	4196	16.93	12.4	77.9	196	0.0	5.0	5.0	5.0
Rima	SES (3/15/89)	2531	10.22	12.3	71.6	217	0.0	4.0	7.0	7.0
R139C7	RZM R039C6,(C39R6)	4184	17.06	12.4	76.4	215	0.0	3.0	4.0	3.0
Lines with FC germplasm										
R020	RZM R920,(C94)	2094	11.27	9.4	67.0	232	0.0	4.0	7.0	5.0
R120	RZM R020	2155	12.46	8.5	70.8	214	0.0	3.0	6.0	5.0
R119	RZM 901008,89141	2001	10.05	9.8	70.8	214	0.0	3.0	6.0	5.0
921009	2 Rhizoc. R920	2187	10.53	10.3	72.8	242	0.0	4.0	7.0	4.0
921010	3 Rhizoc. R720	2277	9.97	11.0	72.6	224	0.0	4.0	5.0	2.0
921011	3 Rhizoc. R820	2003	10.22	9.6	70.9	246	1.0	5.0	6.0	2.0
921016	1 Rhizoc. F_2(FC x B883)	737	5.93	6.1	66.1	157	0.0	6.0	7.0	4.0
921017	1 Rhizoc. FC709 x B883	767	5.54	6.6	63.7	164	0.0	6.0	7.0	2.0
Smooth root accessions										
92RM1	Sm.root x C39R3	1454	7.54	9.5	71.7	192	0.0	5.0	6.0	2.0
92RM2	Sm.root x R820C3	868	5.36	8.1	65.4	168	0.0	5.0	7.0	1.0
92RM3	Sm.root x R720	1473	7.82	9.3	70.1	228	0.0	4.0	6.0	2.0
92RM4	Sm.root x R820C3,C39R	1183	7.07	8.3	61.9	165	0.0	2.0	6.0	2.0
92RM5	Sm. % of sugar x R720	2102	9.93	10.6	73.4	202	0.0	2.0	6.0	2.0
Multigerm lines										
Y131-43,89	BYR Y931-43,-89,(C31-43,-89)	1656	7.94	10.2	65.8	157	0.0	2.0	5.0	4.0
R176-43,89	Y931-43,-89 x R076	2932	12.13	11.9	74.9	170	0.0	3.0	5.0	4.0
XU-6	Chinese Accession	485	3.46	6.8	55.7	126	0.0	5.0	7.0	5.0

TEST RZM 792. EVALUATION OF LINES TO RHIZOMANIA, SALINAS, CA., 1992

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	Beets/ 100' No.	Bolting %	Powdery Mildew Score	Virus Yellows Score	CLS Score
Self-fertile lines and popns										
1913	RZM 0913	2892	12.68	11.5	70.9	182	0.0	4.0	4.0	4.0
1915	RZM 0915	2495	10.22	12.1	75.0	186	0.0	3.0	5.0	4.0
1911- 4	Inc. 9911- 4	3253	12.68	12.8	74.8	228	0.0	4.0	4.0	4.0
1911-14	Inc. 9911-14	2702	10.88	12.4	74.4	183	0.0	5.0	5.0	4.0
Nematode resistant lines										
N144-1(C)	NR 0204-1-#,(R_Z*2xB883)	1495	8.60	8.9	68.2	149	0.0	6.0	6.0	5.0
N144-2(C)	NR 0204-2-#,(R_Z*2xB883)	2089	10.82	9.8	70.2	181	0.0	6.0	6.0	5.0
N144-3(C)	NR 0204-3-#,(R_Z*2xB883)	1763	9.14	9.9	69.4	150	0.0	5.0	7.0	5.0
N152	NR-RZM 0204-2,(R_Z*2xB883)	2436	13.30	9.1	66.6	206	0.0	6.0	6.0	6.0
Monogerm lines and popns										
1852-52	RZM 0852-52	3499	13.93	12.5	77.0	218	0.0	8.7	7.0	4.0
1867R	RZM 0867	3030	13.42	11.2	75.8	209	0.0	6.0	6.0	5.0
1859R	RZM 0859,(C859)	2446	10.71	11.3	71.7	192	0.0	7.0	6.0	7.0
F82-546H3	C562CMS x C546	692	4.39	7.7	68.1	179	0.0	6.0	7.0	7.0
Mean		2105.3	9.99	10.0	70.3	193.7	0.0	4.4	5.6	3.9
LSD (.05)		30.3	26.58	11.9	8.4	16.4	1131.4	33.7	18.6	43.2
C.V. (%)		8.9**	6.03**	9.8**	2.7**	3.7**	1.0NS	3.7**	2.9**	3.3**
F value										

TEST 2692. RHIZOMANIA EVALUATION OF LINES, SALINAS, CA., 1992

64 entries x 8 replications, RCB
1-row plots, 20 ft. long

Planted: April 28, 1992
Harvested: November 2-4, 1992

Variety	Cycle	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters No.	Root Rot No.	RJAP %	P.M. Score Avg.
33 R139C7		RZM R039C6 (C39R7)	9924	34.27	14.6	0	0	82.9	2.4
10 R139C7	C7	RZM R039C6	9701	32.42	15.0	0	0	84.0	2.1
9 R039C6	C6	RZM R939C5	9661	32.76	14.9	0	0	84.1	1.8
8 R039C5	C5	Inc. R939C5 (C39R5)	9451	31.08	15.2	0	0	84.6	1.6
6 R839C4	C4	RZM R739(3)	9445	31.00	15.3	0	0	84.0	2.3
29 R029		RZM 9223	9272	32.02	14.5	0	0	83.4	6.3
7 R939C5	C5	RZM R839C4	9252	31.03	14.9	0	0	83.1	1.4
52 R022R2		RZM R922R	9176	33.49	13.8	0	0	78.2	6.4
53 R122R3		RZM R022R2	9159	32.48	14.2	0	0	79.0	7.0
24 R030		RZM 9225	8995	31.54	14.3	0	0	82.2	4.8
25 R130		RZM R030	8951	33.68	13.4	0	0	78.0	4.4
31 R031		RZM 9228	8932	30.29	14.9	0	0	80.5	6.9
57 R039C5		Inc. R939C5 (C39R)	8852	29.90	14.9	0	0	82.4	2.3
32 R131		RZM R031	8810	28.98	15.3	0	0	82.4	7.9
45 R176-43,-89		C931-43,-89 x R076	8806	30.01	14.7	0	0	84.7	5.3
28 0910		RZM 9910H47 ($747R_z$)	8681	31.92	13.6	0	0	81.4	6.8
30 R129		RZM 0281-#	8627	30.13	14.3	0	0	79.6	6.0
41 Z120		RZM Z010H12	8583	28.01	15.4	0	0	82.1	6.9
50 R080		RZM R980 ($C54R_z$)	8554	28.35	15.1	0	0	83.6	5.4
46 1913		RZM 0913	8515	30.25	14.1	0	0	82.8	5.7
42 Z122		RZM Z012H12	8492	28.29	15.1	0	0	81.9	6.6
47 1915		RZM 0915	8462	29.66	14.3	0	0	81.4	4.6
26 1201-#		C37 x RZM R004	8363	32.74	12.8	0	0	81.6	4.1
64 90-WIV		RZM WIV-89 (Y39xWB151)	8359	26.61	15.7	0	0	81.4	2.7

TEST 2692. RHIZOMANIA EVALUATION OF LINES, SALINAS, CA., 1992

(cont.)

Variety	Cycle	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters No.	Root Rot No.	RJAP %	P.M. Score Avg.
43 Z124		RZM Z014H12	8327	27.54	15.2	0	0	80.0	6.9
62 90-WII		RZM WII-89 (Y52xWB258)	8244	27.47	15.0	0	0	82.6	4.4
4 Y139		BYR Y939 (C39)	7942	25.58	15.6	0	0	82.3	2.3
21 R028		RZM 9221	7769	28.56	13.7	0	0	81.1	6.9
2 Rhizosen		Holly 493302	7759	26.88	14.4	0	0	81.5	7.5
13 R847	C4	RZM R747	7736	27.04	14.3	0	0	83.5	6.1
3 Rima		SES (3/15/89)	7700	25.46	15.1	0	0	79.7	7.7
11 Y147		BYR Y947 (C47)	7698	26.04	14.8	0	0	82.7	3.6
16 R147C7	C7	RZM R047C6	7686	27.20	14.2	0	0	82.3	6.8
35 R104		RZM R004	7612	31.78	12.2	1	0	79.8	4.8
20 R928C1		RZM 8828-# (C28)	7540	29.28	13.0	1	0	82.5	6.0
61 90-WI		RZM WI-89 (Y52 x WB169)	7488	27.93	13.5	0	0	77.1	1.7
38 R107		RZM R007	7422	25.71	14.5	0	0	81.8	7.4
63 90-WIII		RZM WIII-89 (Y52xWB151)	7419	25.06	14.9	0	0	80.3	4.8
39 R108		RZM R008	7368	26.74	13.9	0	0	80.6	5.4
40 R120		RZM R020 (C94)	7367	31.77	11.9	0	0	77.7	5.1
15 R047C6	C6	RZM R947C5	7285	26.23	13.9	0	0	83.1	7.1
55 R122Y2		BYR R922Y	7251	25.57	14.3	0	0	79.8	5.3
22 R128		RZM 0271-#	7089	25.84	13.8	0	0	79.8	7.0
36 R105		RZM R005	7087	23.28	15.2	0	0	80.8	5.8
14 R047C5	C5	Inc. R947C5 (C47R5)	7087	24.71	14.3	0	0	84.1	6.3
48 1914		RZM 0914	7040	25.80	13.7	0	0	81.4	2.4
54 R022Y		Inc. R922Y	6946	25.81	13.6	0	0	80.6	5.1
18 R079		RZM R979 ($C37R_Z$)	6889	24.47	14.1	0	0	82.5	6.2

TEST 2692. RHIZOMANIA EVALUATION OF LINES, SALINAS, CA., 1992

(cont.)

	Variety	Cycle	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters No.	Root Rot No.	RJAP %	P.M Score Avg.
5	Y439	CO	Inc. Y339	6806	22.84	14.9	0	0	82.1	2.5
56	R121		BYR R921,4,5 (C48)	6612	22.81	14.5	0	0	81.7	7.1
51	R722		Inc. F_2(Y54xB.m.) (C50)	6555	24.44	13.4	1	0	78.9	5.2
12	Y547	CO	YR-ER-PMR	6212	22.20	13.9	0	0	80.4	4.5
37	R106		RZM R006	6125	21.13	14.5	0	0	82.9	6.3
27	5747		4747aa x A	5994	22.91	13.1	0	0	81.9	6.6
44	C131-43,-89		BYR Y931-43,-89	5993	21.25	14.1	0	0	82.4	4.2
19	1204-#		C37 x R079	5940	20.89	14.1	0	0	84.2	7.3
59	1211,13,15		C37 x (SB x WB97)	5858	21.85	13.4	0	0	79.9	4.9
49	Y954		Inc. Y854 (C54)	5554	20.59	13.4	0	0	80.2	3.4
60	1212,14,16		C37 x (SB x WB242)	5437	20.02	13.5	0	0	80.2	2.6
17	U86-37		Inc. C37 (86443)	5370	19.54	13.7	0	0	81.7	7.3
23	1202-#		C37 x RZM 0271	5308	19.63	13.6	0	0	81.5	7.2
34	US H11		L113401	4896	21.37	11.5	0	0	77.8	7.8
1	US H11		L113401	4835	19.69	12.3	0	0	80.9	7.9
58	US H11		L113401	4400	19.22	11.5	0	0	77.7	7.6
Mean				7604.2	26.92	14.1	0.08	0.00	81.4	5.3
LSD (.05)				1076.0	3.67	0.7	0.33	0.06	3.3	1.2
C.V. (%)				14.4	13.86	5.4	423.05	1601.81	4.1	23.7
F value				12.2**	10.07**	12.6**	4.20**	0.98NS	2.4**	18.9**

TEST RZM 492. RHIZOMANIA EVALUATION OF C0 vs C7 SYNTHETICS, SALINAS, CA., 1992

16 entries x 8 replications, RCB
1-row plots, 18 ft. long

Planted: June 5, 1992
Harvested: November 16, 1992

Variety	Cycle	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	Beets/ 100' No.	Powdery Mildew Score	Virus Yellows Score	CLS Score
Checks										
US H11		L113401	1043	5.63	9.2	72.1	167	5.0	5.0	7.0
Rhizosen		Holly 493302	2653	12.16	10.8	76.6	197	3.0	4.0	6.0
Rima		SES (3/15/89)	2686	11.08	12.1	72.2	218	6.0	6.0	8.0
Selection within C39										
Y139	YRS	BYR Y939	2409	8.99	13.4	78.1	198	1.0	4.0	5.0
Y439	C0	Inc. Y339 (Iso)	2212	9.04	12.3	76.7	183	1.0	4.0	4.0
R839C4	C4	RZM R739(3)	4007	15.55	12.8	78.8	196	1.0	4.0	5.0
R939C5	C5	RZM R839C4	3430	13.70	12.5	75.4	202	1.0	4.0	4.0
R039C5	C5	Inc. R939C5	3626	15.40	11.8	73.1	184	1.0	4.0	4.0
R039C6	C6	RZM R939C5	4086	16.29	12.7	76.3	212	1.0	4.0	5.0
R139C7	C7	RZM R039C6	3879	16.56	11.6	73.4	223	2.0	3.0	5.0
Selection within C47										
Y147	YRS	BYR Y947	2504	9.42	13.2	76.8	206	2.0	4.0	5.0
Y547	C0	YR-ER-PMR	2043	8.89	11.5	75.4	188	3.0	5.0	6.0
R847	C4	RZM R747	2744	11.58	11.8	75.2	227	4.0	4.0	5.0
R047C5	C5	Inc. R947C5	2573	11.31	11.4	76.6	197	3.0	3.0	5.0
R047C6	C6	RZM R947C5	2703	12.23	11.1	75.6	223	4.0	3.0	5.0
R147C7	C7	RZM R047C6	2589	11.55	11.2	75.2	215	4.0	4.0	4.0

TEST RZM 592. RHIZOMANIA EVALUATION OF LINES DERIVED FROM PI206407, SALINAS, CA., 1992

16 entries x 8 replications, RCB
1-row plots, 18 ft. long

Planted: June 5, 1992
Harvested: November 17, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	Beets/ 100' No.	Bolting %	Powdery Mildew Score	Virus Yellows Score	CLS Score
C37 background										
U86-37	Inc. C37 (86443)	1360	5.79	11.8	74.0	186	0.0	5.0	4.0	5.0
R079	RZM R979 ($C37R_z$)	2642	10.33	12.9	76.6	199	0.0	4.0	4.0	4.0
R928C1	RZM 8828-# (C37 x PI07)	2028	9.17	11.1	72.3	161	0.9	3.0	5.0	4.0
R028	RZM 9221 (C37*2xPI07)	2846	11.55	12.3	75.8	197	0.0	5.0	5.0	5.0
R128	RZM 0271-# (C37*3xPI07)	2584	9.91	12.9	74.5	204	0.0	5.0	5.0	5.0
R030	RZM 9225,F_2($C37R_z$xR928)	3303	12.86	12.7	77.1	204	0.0	2.0	5.0	5.0
R130	RZM R030,F_3($C37R_z$xR928)	3406	13.40	12.7	75.8	206	0.0	2.0	4.0	5.0
747 background										
5747	4747aa x A	1866	8.39	10.9	71.7	165	0.0	6.0	5.0	3.0
0910	RZM 9910H47,($747R_z$)	4076	16.44	12.5	76.6	211	0.0	5.0	5.0	3.0
R029	RZM 9223,(747xPI07)	3455	13.29	12.9	75.0	216	0.0	5.0	5.0	3.0
R129	RZM 0281-#,(747*2xPI07)	2808	12.18	11.5	74.3	196	0.0	5.0	6.0	4.0
R031	RZM 9228,F_2($747R_z$xR029)	4188	15.64	13.3	76.2	204	0.0	5.0	6.0	5.0
R131	RZM R031,F_3($747R_z$xR029)	3809	14.67	13.0	75.9	226	0.0	7.0	6.0	6.0
R_z x Polish										
Z120	RZM Z010H12,F_2($R_z$aaxPolish)	3441	12.24	14.0	77.7	190	0.0	5.0	5.0	5.0
Z122	RZM Z012H12,F_2($R_z$aaxPolish)	3167	11.84	13.3	75.9	187	0.0	4.0	6.0	5.0
Z124	RZM Z014H12,F_2($R_z$aaxPolish)	3726	13.13	14.1	78.1	204	0.0	4.0	5.0	4.0

TEST RZM 692. RHIZOMANIA EVALUATION OF LINES DERIVED FROM B.MARITIMA, SALINAS, CA., 1992

16 entries x 8 replications, RCB
1-row plots, 18 ft. long

Planted: June 5, 1992
Harvested: November 18, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	Beets/ 100' No.	Bolting %	Powdery Mildew Score	Virus Yellows Score	CLS Score
Checks										
Y954	Inc. Y854	1314	5.44	11.8	74.5	155	0.0	2.0	6.0	6.0
R080	RZM R980 ($C54R_2$)	3625	13.73	13.2	76.8	204	0.0	4.0	5.0	5.0
US H11	L113401	1103	5.58	9.6	71.1	160	0.0	5.0	6.0	6.0
1913	RZM 0913	2809	11.85	11.8	73.7	181	0.0	4.0	5.0	4.0
R139C7	RZM R039C6	4154	16.13	12.8	77.1	202	0.0	2.0	4.0	4.0
Beta maritima source										
R722	Inc. F_2(Y54 x B.m.)(C50)	1682	7.26	11.5	70.7	170	0.9	2.0	5.0	6.0
R022R2	RZM R922R	3777	16.47	11.4	71.0	199	0.0	4.0	5.0	6.0
R122R3	RZM R022R2	4020	16.78	12.0	72.9	212	0.0	4.0	6.0	6.0
R022Y	Inc. R922Y	2036	8.71	11.6	71.4	190	0.0	4.0	5.0	5.0
R122Y2	BYR R922Y	2424	9.57	12.6	71.8	172	0.0	3.0	5.0	5.0
R121	BYR R921,4,5, (C48)	1748	7.54	11.6	71.4	190	0.0	4.0	5.0	5.0
Italian source										
R104	RZM R004	2384	12.56	9.5	70.8	189	0.0	2.0	5.0	5.0
R105	RZM R005	1488	5.80	12.7	74.0	195	0.0	4.0	7.0	4.0
R106	RZM R006	1162	4.98	11.5	73.0	193	0.0	6.0	8.0	6.0
R107	RZM R007	2107	8.44	12.4	74.2	213	0.0	5.0	7.0	5.0
R108	RZM R008	2731	11.50	11.8	73.0	174	0.0	3.0	6.0	5.0

TEST 2792. RHIZOMANIA EVALUATION OF LINES AND THEIR HYBRIDS, SALINAS, CA., 1992[1]

32 entries x 8 replications (RCB)
1-row plots, 20 ft. long

Planted: April 28, 1992
Harvested: October 29, 1992

Variety[2]	Description[2]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	PM Score Avg.
Checks						
US H11	L113401	2338	11.40	10.3	75.6	6.8
Rhizosen	Holly (L493302)	4727	17.13	13.8	80.2	6.8
Rima	SES	5297	17.43	15.2	80.8	7.1
Line & Hybrid combinations						
R039C5	Inc. R939C5 (C39R)	6264	21.70	14.5	81.4	2.2
R039C5H18	88-790-68H26 x R939C5	4851	17.89	13.7	81.9	4.3
R039C5H132	9865aa x R939C5	5915	20.50	14.5	81.1	4.9
Y039	Inc. Y939 (C39)	4243	14.83	14.4	81.8	1.8
Y039H18	88-790-68H26 x Y939	3604	13.83	13.0	81.8	4.1
Y039H132	9865aa x Y939	5157	17.97	14.3	81.4	4.9
R047C5	Inc. R947C5 (C47R)	4374	16.17	13.5	81.3	5.3
R047C5H18	88-790-68H26 x R947C5	4080	16.18	12.6	78.3	5.9
R047C5H132	9865aa x R947C5	5449	19.71	13.9	80.6	7.4
Y047	Inc. Y947 (C47)	5072	18.70	13.6	80.8	4.1
Y047H18	88-790-68H26 x Y947	3907	15.34	12.8	81.3	4.9
Y047H132	9865aa x Y947	5288	19.13	13.8	80.9	6.9
R070	Inc. R971-R980	5519	20.29	13.6	80.4	5.9
R070H18	88-790-68H26 x R971-R980	5518	19.50	14.1	81.7	6.2
R070H113	9867H67aa x R971-R980	5713	20.96	13.6	80.6	5.6
R080	Inc. R980	4830	17.43	13.9	80.7	4.1
R080H18	88-790-68H26 x R980	5792	20.92	13.8	80.6	5.6
R080H132	9865aa x R980	6172	21.78	14.1	79.5	6.6

TEST 2792. RHIZOMANIA EVALUATION OF LINES AND THEIR HYBRIDS, SALINAS, CA., 1992[1]

(cont.)

Variety[2]	Description[2]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	PM Score Avg.
Line & Hybrid combinations (cont.)						
R020	Inc. R920 (C94)	5203	20.56	12.7	77.7	4.3
R020H18	88-790-68H26 x R920	4252	17.15	12.4	78.9	5.6
R020H132	9865aa x R920	5332	20.27	13.1	79.2	6.3
0913	9911H49aa x A	5347	19.65	13.6	79.9	4.1
0913H18	88-790-68H26 x 9911H49	5247	19.44	13.5	79.0	6.2
0913H132	9865aa x 9911H49	6126	22.40	13.7	81.6	6.8
Z010	Inc. P1,...,P7	1692	6.42	13.3	78.3	6.3
Z010H18	88-790-68H26 x P1-P7	2944	12.07	12.3	76.2	6.1
Z010H113	9867H67aa x P1-P7	4786	17.99	13.3	78.1	7.3
Z120	RZM Z010H12	5108	17.29	14.8	80.6	6.8
1915	RZM 0915	5317	19.23	13.9	80.8	3.4
Mean		4858.3	17.85	13.6	80.1	5.4
LSD (.05)		1024.0	3.66	0.6	2.7	1.2
C.V. (%)		21.4	20.78	4.6	3.4	23.2
F value		8.3**	6.70**	16.4**	2.8**	10.3**

[1]Test 2792 was grown adjacent to Test 2592-2 and under the same conditions & treatments. Rhizomania was severe. Virus yellows and curly top were moderate. Plot weights were adjusted for gaps and areas of severe infection by curly top and/or Aphanomyces.

[2]R039C5 = C39R = line with quantitative resistance developed at Salinas. Y039 = C39 = line with same source as C39R but selected for resistance to virus yellows. R047C5 = C47R. Y047 = C47. R070 = composite cross of lines and it segregates for $R_z:r_zr_z$. R080 = $C54R_z$. R020 - C94. 0913 = MM,S^f,A:aa,$R_z:r_zr_z$ population. Z010 = composite of 2N-Polish-Z germplasm. Z120 = F_2(popn-912$R_z$aa x 2N-Polish-Z lines). 1915 = MM,S^f,A:aa,$R_z:r_zr_z$ population. 88-790-68H26 = C309CMS x C790-68 and is susceptible to rhizomania. 9865 and 9867H67 = mm,S^f,A:aa,$R_zr_zr_z$ populations.

TEST RZM 892. SELECTION FOR RHIZOMANIA RESISTANCE WITHIN SMOOTH ROOT POPNS, SALINAS, CA., 1992

7 entries x 4 replications
1-row plots, 12 ft. long

Planted: June 5, 1992
Harvested: November 23, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	Beets/ 100' No.	Powdery Mildew Score	Virus Yellows Score	CLS Score
92RM1	Sm.Root x C39R3	2689	12.30	10.9	74.0	242	3.8	5.0	4.5
92RM2	Sm.Root x R820C3	1584	7.84	9.9	74.6	194	4.6	6.0	5.4
92RM3	Sm.Root x R720	2337	11.36	10.4	71.5	246	5.0	5.8	4.5
92RM4	Sm.Root x R820C3,C39R3	1535	8.65	8.9	69.9	225	3.8	4.6	3.8
92RM5	% Sugar x R720	2202	9.63	11.4	74.2	217	3.8	5.1	5.0
US H11	Susc. check	923	5.36	8.6	72.2	187	4.8	4.5	6.3
Rhizosen	Resist. check	3734	15.43	12.2	74.4	198	5.8	4.5	6.3
Mean		2143.6	10.08	10.3	73.0	215.4	4.5	5.1	5.1
LSD (.05)		692.5	2.89	1.2	4.6	37.8	1.8	0.9	1.2
C.V. (%)		21.8	19.31	7.8	4.3	11.8	26.4	11.8	15.9
F value		15.5**	11.39**	10.2**	1.3NS	3.4*	1.7NS	4.1**	5.4**

TEST 2592-1. CBGA/BSDF CODED RHIZOMANIA YIELD TEST, SALINAS, CA., 1992

64 entries x 8 reps, RCB
1-row plots, 20 ft. long

Planted: April 28, 1992
Harvested: October 26-28, 1992

Code	Variety[1]	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	PM Score[2] Avg	RJAP %
CBGA Coded										
12	C39R5	Check	9794	35.32	13.9	0.0	0.0	169	1.9	82.1
10	1J0162	Beta	9601	35.02	13.8	0.3	0.0	226	2.2	81.4
40	1J5087	Beta	9502	36.10	13.3	0.0	0.0	201	2.3	81.1
41	90U 39R4/6-05	Holly	9089	34.67	13.1	0.0	0.0	174	4.7	80.9
38	Rima	Check	8606	29.59	14.5	0.0	0.0	202	7.6	80.0
28	SS-781R	Spreck	8574	31.91	13.4	0.0	0.0	206	5.9	82.5
35	H88289	Spreck	8545	30.23	14.2	0.0	0.0	224	5.9	81.1
25	HM 3027	Hill-MH	8537	33.23	13.0	0.0	0.0	209	4.2	80.3
21	90-1459-0188	Holly	8529	29.85	14.3	0.0	0.0	208	6.8	84.1
32	90-1459-0168	Holly	8457	30.77	13.8	0.0	0.4	213	7.6	81.7
42	SS-780R	Spreck	8454	33.09	12.8	0.0	0.0	208	6.1	82.2
34	90C 68-04	Holly	8245	31.23	13.2	0.0	0.0	163	6.1	80.8
29	SS-293R	Spreck	8225	30.71	13.5	0.0	0.0	231	5.6	81.7
23	90C 60-05	Holly	8211	33.03	12.6	0.0	0.0	167	6.4	79.7
27	SS-261R	Spreck	8115	30.11	13.4	0.0	0.0	215	5.8	82.1
1	4581	Beta	8077	29.61	13.7	0.0	0.0	204	2.3	82.4
39	90C 68-03	Holly	8027	29.91	13.5	0.0	0.0	175	6.8	80.5
5	HM 3026	Hill-MH	7953	29.40	13.6	0.0	0.0	233	5.4	82.7
7	SS-593R	Spreck	7932	30.67	13.0	0.0	0.0	206	5.8	80.8
15	90C 64-05	Holly	7917	30.24	13.2	0.0	0.0	189	6.3	80.1
33	SS-292R	Spreck	7917	30.37	13.1	0.0	0.0	205	6.1	78.7
22	90-88C11-010	Holly	7826	29.51	13.3	0.0	0.0	206	7.6	81.4
6	HM 3028	Hill-MH	7782	28.77	13.5	0.0	0.0	235	8.1	80.9
31	90U 39R4/6-03	Holly	7735	30.44	12.9	0.0	0.0	205	4.5	81.5

TEST 2592-1. CBGA/BSDF CODED RHIZOMANIA YIELD TEST, SALINAS, CA., 1992

(cont.)

Code	Variety[1]	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	PM Score[2] Avg	RJAP %
CBGA Coded (cont.)										
36	90-88C11-09	Holly	7670	28.37	13.6	0.0	0.0	219	6.9	82.4
16	90C 68-06	Holly	7664	29.42	13.1	0.0	0.0	199	6.4	83.0
9	90-1459-0161	Holly	7632	28.65	13.3	0.0	0.0	188	6.1	80.0
37	90C 64-03	Holly	7499	29.41	12.8	0.0	0.0	173	5.8	80.3
19	SS-462R	Spreck	7391	28.93	12.9	0.0	0.0	225	8.3	79.8
20	SS-287R	Spreck	7380	29.03	12.8	0.0	0.0	211	6.1	80.2
13	91-89C58-05	Holly	7325	27.39	13.5	0.0	0.0	198	6.4	82.4
18	90-84C65-032	Holly	7315	25.73	14.3	0.0	0.0	226	6.6	80.9
4	H88463	Spreck	7298	27.28	13.4	0.0	0.0	228	7.9	79.1
11	SS-334R	Spreck	7278	26.25	13.9	0.0	0.0	208	8.1	80.0
26	SS-595R	Spreck	7215	27.39	13.2	0.0	0.0	220	5.7	81.3
8	H88464	Spreck	7146	28.33	12.6	0.0	0.0	221	8.3	76.9
17	H88596	Spreck	7057	27.20	13.0	0.0	0.0	223	5.9	81.6
43	90-88C11-02	Holly	6922	27.26	12.8	0.0	0.0	219	5.8	82.6
3	Rhizosen	Check	6916	27.27	12.7	0.0	0.0	212	6.9	82.0
2	90-87C34-06	Holly	6833	26.72	12.8	0.0	0.0	196	7.3	80.6
14	H91468	Spreck	6440	24.94	12.9	0.0	0.0	204	7.8	79.7
24	Rhizosen	Holly	6432	25.75	12.5	0.0	0.0	204	6.2	80.6
30	US H11	Check	4032	18.88	10.6	0.0	0.0	226	7.2	77.6
BSDF Entries										
44	Beta-1	4/8/92	9723	31.80	15.3	0.0	0.0	197	6.5	82.1
47	Beta-4	4/8/92	9376	34.47	13.7	0.0	0.0	203	3.8	81.4
45	Beta-2	4/8/92	9292	32.38	14.4	0.0	0.0	209	6.7	81.5
49	Maribo-1	Am.Cry.	8669	30.79	14.2	0.0	0.0	213	5.1	80.0
46	Beta-3	4/8/92	7978	27.95	14.3	0.0	0.0	200	7.1	82.8
48	Beta-5	4/8/92	7426	27.98	13.4	0.0	0.0	151	6.6	81.8

TEST 2592-1. CBGA/BSDF CODED RHIZOMANIA YIELD TEST, SALINAS, CA., 1992

(cont.)

Code	Variety[1]	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	PM Score[2] Avg	RJAP %
USDA Entries										
57	R039C5H113	aa x C39R5	9503	35.39	13.5	0.0	0.0	204	3.9	83.3
56	R139C7	C39R7	9220	35.07	13.3	0.0	0.0	181	1.6	81.7
62	R122R3	C50R3	8983	34.86	12.9	0.0	0.0	211	6.4	76.0
64	R131	R_z x PI07	8456	30.74	13.8	0.0	0.0	197	7.6	80.6
54	Z010H12	F_1 popn	8336	28.91	14.5	0.0	0.0	193	6.0	81.2
58	1913	popn-913	8274	31.68	13.1	0.0	0.0	210	4.4	80.1
60	1915	popn-915	8246	32.43	13.0	0.0	0.0	200	4.2	80.9
59	0913H113	aa x 913	8152	32.66	12.6	0.0	0.0	225	5.4	79.1
50	Rhizosen	L493302	8033	29.61	13.6	0.0	0.0	201	6.4	82.5
53	Rizor	SES, 4/87	8021	28.57	14.1	0.0	0.0	213	7.6	80.5
55	Z120	F_2 popn	7914	28.91	13.8	0.0	0.0	202	6.5	79.4
61	R147C7	C47R7	7505	29.24	12.9	0.0	0.0	218	5.3	80.5
63	R129	aa x PI07	6435	27.65	11.8	1.0	0.0	204	5.9	78.6
51	HH 41	L412305	5822	23.87	12.2	0.0	0.0	218	5.7	82.2
52	US H11	L113401	4473	21.40	10.5	0.0	0.3	238	6.4	78.4
Mean			7892.4	29.76	13.3	0.02	0.01	205.6	5.95	80.87
LSD (.05)			1004.0	3.52	0.7	0.26	0.16	22.0	1.01	2.82
C.V. (%)			12.9	12.04	5.1	1339.18	1622.22	10.9	17.20	3.55
F value			8.9**	6.60**	11.0**	1.79**	0.98NS	5.2**	18.39**	2.19**

Note: Sugarbeet had not been grown in this plot area since 1987. Rhizomania was moderate. Most plants became established without severe infection, but through the season, symptoms became moderate. The level of infection across the field was fairly uniform and it was felt that rhizomania was the major determinant on the final yields. Moderate infestation of cyst nematode was evident at harvest. Black aphids were an

ongoing problem and were sprayed three times with aphicides. Virus yellows (BYV/BWYV) was moderate. The first curly top virus infested plants were observed in the seedling stage and overall infection was moderate. Differential effects were evident among entries. Highly CT susceptible entries, e.g., R129, Rizor, Maribo-1, etc., appeared to have significant yield reduction. However, in most plots, there was a mixture of early and late infected and noninfected plants.

[1]Entries 1-43 were coded entries from CBGA. Entries 50-64 were included by the USDA. Z010H12 and Z120 = popn-912(R_z)aa x Polish. R039C5H113 and 0913H113 = popn-867(R_z)aa x C39C5 and popn-913R_z. R122R3 = cycle 3 rhizomania resistant selection C50 (Y54 x B. maritima). R129 = line with resistance from PI206407 (C28's source of resistance). R131 = line with resistance from R_z and PI206407.

[2]Until late summer, powdery mildew was controlled with Bayleton. After Bayleton lost its effacacy, PM was scored at its peak development on 9/10 and 9/21 on a scale of 0 to 9.

TEST 2592-2. CBGA/BSDF CODED RHIZOMANIA SCORED TEST, SALINAS, CA., 1992

64 entries x 4 reps, RCB
1-row plots, 20 ft. long

Planted: April 28, 1992
Harvested: November 5, 1992

Code	Variety	Source	Acre Yield[1] Sugar Lbs	Acre Yield[1] Beets Tons	Acre Yield[2] Sugar Lbs	Acre Yield[2] Beets Tons	Missing Feet[1] No.	Sucrose %	PM Score Avg	RJAP %
CBGA Coded										
40	1J5087	Beta	7250	24.42	6346	21.53	3	15.0	2.1	85.1
10	1J0162	Beta	6821	22.58	6821	22.58	0	15.1	3.3	84.6
32	90-1459-0168	Holly	6744	22.50	6204	20.69	2	14.9	7.3	82.8
41	90U 39R4/6-05	Holly	6684	23.84	5685	20.37	3	13.9	3.9	83.4
34	90C 68-04	Holly	6675	23.99	6018	21.63	2	13.9	5.6	79.5
38	Rima	Check	6350	20.85	5759	18.90	2	15.2	7.3	81.3
21	90-1459-0188	Holly	6301	20.45	5439	17.64	3	15.4	5.9	84.7
37	90C 64-03	Holly	6247	21.24	5094	17.33	4	14.7	5.5	84.3
24	Rhizosen	Holly	6186	21.30	5519	19.01	2	14.5	6.3	81.7
18	90-84C65-032	Holly	6186	19.95	5354	17.33	3	15.3	5.4	81.5
35	H88289	Spreck	6131	20.86	5931	20.16	1	14.6	5.3	80.6
5	HM 3026	Hill-MH	6058	20.27	5656	18.90	2	14.8	5.9	83.5
39	90C 68-03	Holly	6014	19.60	5120	16.69	3	15.3	7.1	84.8
42	SS-780R	Spreck	6012	21.96	5101	18.69	3	13.6	6.5	81.9
28	SS-781R	Spreck	5985	20.76	5773	20.06	1	14.5	6.5	82.5
12	C39R5	Check	5950	18.54	5664	17.64	1	16.0	1.5	83.3
36	90-88C11-09	Holly	5934	20.94	5164	18.17	3	14.1	5.9	81.0
25	HM 3027	Hill-MH	5916	20.55	5662	19.74	1	14.5	4.8	81.9
27	SS-261R	Spreck	5859	20.65	5432	19.11	2	14.2	5.9	81.9
13	91-89C58-05	Holly	5835	20.23	4695	16.28	4	14.4	5.5	82.5

TEST 2592-2. CBGA/BSDF CODED RHIZOMANIA SCORED TEST, SALINAS, CA., 1992

(cont.)

Code	Variety	Source	Acre Yield[1] Sugar Lbs	Acre Yield[1] Beets Tons	Acre Yield[2] Sugar Lbs	Acre Yield[2] Beets Tons	Missing Feet[1] No.	Sucrose %	PM Score Avg	RJAP %
CBGA Coded (cont.)										
23	90C 60-05	Holly	5826	21.06	5074	18.27	3	13.9	5.8	81.4
29	SS-293R	Spreck	5712	18.78	5203	17.11	2	15.3	6.0	82.0
33	SS-292R	Spreck	5517	20.00	5243	19.01	1	13.8	6.1	79.4
3	Rhizosen	Check	5449	18.45	4716	15.96	3	14.8	5.3	82.4
4	H88463	Spreck	5443	19.14	4502	15.86	4	14.2	7.1	80.8
16	90C 68-06	Holly	5391	19.14	4682	16.59	3	14.1	6.1	82.8
11	SS-334R	Spreck	5371	18.76	4471	15.54	3	14.3	7.9	79.0
22	90-88C11-010	Holly	5370	19.16	4353	15.65	4	13.9	7.1	81.5
15	90C 64-05	Holly	5343	18.01	5183	17.43	1	14.6	6.0	81.0
31	90U 39R4/6-03	Holly	5169	18.75	4925	17.85	1	13.8	3.6	82.5
2	90-87C34-06	Holly	5168	17.75	4002	13.76	5	14.4	6.3	84.1
26	SS-595R	Spreck	5159	18.30	4514	15.96	3	14.0	7.0	79.2
14	H91468	Spreck	5159	17.70	4812	16.49	2	14.5	6.5	82.6
7	SS-593R	Spreck	5154	17.76	4845	16.70	1	14.5	5.4	81.0
9	90-1459-0161	Holly	5065	18.01	4128	14.70	4	14.1	6.0	79.5
8	H88464	Spreck	4982	17.83	3733	13.34	5	14.0	7.3	79.5
1	4581	Beta	4875	17.33	4419	15.65	2	14.1	1.5	79.3
20	SS-287R	Spreck	4730	16.76	4155	14.70	3	14.1	6.5	81.2
6	HM 3028	Hill-MH	4667	16.37	4161	14.60	2	14.2	7.6	83.2
17	H88596	Spreck	4364	15.36	4323	15.23	0	14.1	6.5	78.0
43	90-88C11-02	Holly	3712	13.90	3464	12.92	2	13.2	5.3	81.3
19	SS-462R	Spreck	3619	12.56	2293	7.98	8	14.4	7.5	81.3
30	US H11	Check	3292	14.49	3004	13.23	2	11.2	6.3	73.6

TEST 2592-2. CBGA/BSDF CODED RHIZOMANIA SCORED TEST, SALINAS, CA., 1992

(cont.)

Code	Variety	Source	Acre Yield[1] Sugar Lbs	Acre Yield[1] Beets Tons	Acre Yield[2] Sugar Lbs	Acre Yield[2] Beets Tons	Missing Feet[1] No.	Sucrose %	PM Score Avg	RJAP %
BSDF Entries										
47	Beta-4	4/8/92	7465	24.35	6930	22.68	1	15.2	1.3	84.6
46	Beta-3	4/8/92	6907	24.49	5347	19.01	4	14.1	6.4	81.6
45	Beta-2	4/8/92	6829	22.33	6573	21.53	1	15.4	6.0	83.6
44	Beta-1	4/8/92	6745	21.17	4902	15.12	6	15.9	5.3	83.4
49	Maribo-1	Am.Cry.	6586	21.40	6370	20.69	1	15.4	5.4	83.2
48	Beta-5	4/8/92	5754	20.30	3357	11.76	8	14.3	5.3	82.0
USDA Entries										
62	R122R3	C50R3	8354	30.87	8354	30.87	0	13.6	6.9	77.3
56	R139C7	C39R7	6540	21.52	5989	19.64	2	15.3	1.3	82.0
64	R131	R_Z x PI07	6480	21.74	5631	18.90	3	15.0	7.0	84.0
57	R039C5H113	aa x C39R5	6346	21.01	5877	19.53	2	15.2	3.3	83.3
50	Rhizosen	L493302	5911	20.12	5241	17.85	2	14.7	6.0	83.2
58	1913	popn-913	5755	19.96	5262	18.27	2	14.5	5.5	82.0
55	Z120	F_2 popn	5656	18.75	4456	14.81	4	15.1	6.4	79.8
53	Rizor	SES, 4/87	5586	18.98	4210	14.39	5	14.6	5.6	79.8
60	1915	popn-915	5571	19.41	5355	18.69	1	14.4	4.9	82.4
54	Z010H12	F_1 popn	5513	18.13	5238	17.22	1	15.2	6.4	82.6
59	0913H113	aa x 913	5341	18.81	4860	17.11	2	14.2	5.8	81.9
63	R129	aa x PI07	4774	16.85	4199	14.81	2	14.2	6.0	81.5
61	R147C7	C47R7	4448	15.67	4291	15.12	1	14.3	6.4	80.8
51	HH 41	L412305	3213	13.09	2706	11.13	3	11.7	5.6	73.3
52	US H11	L113401	2738	11.60	2335	9.98	3	11.7	6.1	76.0

TEST 2592-2. CBGA/BSDF CODED RHIZOMANIA SCORED TEST, SALINAS, CA., 1992

(cont.)

Code	Variety	Source	Acre Yield[1] Sugar Lbs	Acre Yield[1] Beets Tons	Acre Yield[2] Sugar Lbs	Acre Yield[2] Beets Tons	Missing Feet[1] No.	Sucrose %	PM Score Avg	RJAP %
Mean			5659.2	19.55	5001.9	17.28	2.4	14.4	5.6	81.5
LSD (.05)			1437.0	4.91	1518.0	5.22	2.7	1.1	1.3	4.2
C.V. (%)			18.2	18.00	21.8	21.65	80.2	5.3	17.0	3.7
F value			3.9**	3.11**	3.9**	3.33**	2.7**	5.2**	10.2**	2.4**

Note: See Test 2592-1. Test 2592-2 was under severe rhizomania conditions. Thea rea where 2592-2 was planted was in sugarbeet rhizomania tests in 1991. The original intent of Test 2592-2 was to have a four replication companion test to 2592-1 that could be lifed and visually scored for rhizomania. However, because of the severity of rhizomania and other root problems, Test 2592-2 was not scored for rhizomania but was harvested for yield. In addition to rhizomania being severe and affecting most roots, other root problems would have made it very difficult to score individual roots. During stand establishment, a seedling problem (Aphanomyces) was severe in some areas. Most affected plants survived and there were nearly full stands. The Aphanomyces affected plants never recovered and produced a good root system. They remained stunted with symptoms similar to rhizomania. Curly top virus also was moderately severe in some areas of the test. Plants stunted by severe rhizomania and Aphanomyces were apparently conducive to leaf hopper feeding and also became severely infected by curly top. CT also causes root symptoms that mimic rhizomania.

[1]The yield data for Test 2592-2 are presented two ways. The first is with yield adjustments for plots or parts of plots that appeared to be differentially affected by Aphanomyces and curly top. The adjustment factor (missing feet of row per plot) was also analyzed and is presented.

[2]The second analysis was for unadjusted plot data. Because stand counts were to have been made when the beets were scored for rhizomania, no stand data was taken for Test 2592-2. However, plots were thinned simultaneously and to the same spacing as Test 2592-1.

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1992

150 entries x 3 replications

Test Conducted by Terry Brown, BSDF

Variety	Description	CT Grade[1] 1st Rating	CT Grade 2nd Rating	Variety	Description	CT Grade 1st Rating	CT Grade 2nd Rating
HYBRIDS				MULTIGERM, O.P.			
US H11	(C562 x C546) x C36	5.0	5.8	768	Inc. 868 (US 75)	5.2	5.8
WS-PM 9	Hilleshog	4.7	5.8	86-37	Inc. C37	4.8	5.8
HH 84	Holly	5.5	6.3	R128	RZM (C37*3 x PI206407)	5.0	6.0
SS-NB3	Spreckels	5.0	5.8	9101	Inc. C11T	6.8	8.0
R080H20	(C562 x C309) x R980	5.3	6.0	9102	Inc. C12T	7.3	8.2
Y931SH20	(C562 x C309) x C31/6	5.2	6.0	86-46/2	Inc. C46/2	5.0	6.2
Y039H20	(C562 x C309) x C39	5.2	5.8	R078	RZM R978C2 ($C46R_z$)	5.3	6.3
Y047H20	(C562 x C309) x C47	5.2	5.8	86-31/6	Inc. C31/6	6.0	7.2
Z010H20	(C562 x C309) x Polish-C	6.0	6.7	R076	RZM R976 ($C31R_z$)	5.8	7.0
0913H20	(C562 x C309) x popn-913	4.8	5.8	Y131-43	C31/43	6.2	7.0
R080H8	(C562 x C546) x R980	5.0	5.8	Y131-89	C31-89	5.8	7.0
R080H18	(C309 x C790-68) x R980	5.2	6.2	R176-43(C)	C31-43 x R076	6.3	7.3
R080H23	(C306 x C309) x R980	5.0	6.0	R176-89(C)	C31-89 x R076	6.0	6.8
R080H26	C309 x R980	5.0	6.2	R070	RZM R971-R980	5.5	6.5
R080H37	C306 x R980	5.0	6.0	Y054	YRS Y854 (C54)	5.5	6.5
R080H39	C762-17 x R980	5.0	5.7	R080	RZM R980 ($C54R_z$)	5.7	6.7
R080H54	C767-46 x R980	5.2	6.2	R080- 1	R980- 1 x R980	5.7	6.7
R080H70	C766-62 x R980	5.2	5.8	R080-13	R980-13 x R980	5.5	6.5
R080H3	C562 x R980	5.0	6.0	R080-28	R980-28 x R980	5.7	6.5
R080H89	C790-68 x R980	5.2	6.2	R080-35	R980-35 x R980	6.5	7.8
R080H90	popn-C790(C4)aa x R980	5.2	6.0	R080-45	R980-45 x R980	5.7	6.8
R080H29	C790- 6aa x R980	5.0	6.0	R080-56	R980-56 x R980	6.3	7.2
R080H30	C790-15aa x R980	5.0	6.2	R080-79	R980-79 x R980	5.8	6.3
R080H33	C790-54aa x R980	5.2	5.8	R080-80	R980-80 x R980	6.2	7.2
0913H39	C762-17 x popn-913	4.8	5.7	R121	YRS R921 (C48)	5.2	5.8
US H11	(C562 x C546) x C36	5.0	5.8	1211,13,15	C37 x (C37 x WB97)	5.0	5.8

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1992
(cont.)

Variety	Description	CT Grade[1] 1st Rating	CT Grade[1] 2nd Rating
MULTIGERM, O.P.			
1214,16,18	C37 x (C37 x WB242)	5.2	5.8
R122R3	RZM R022R2 (C50R3)	6.0	7.3
R122Y2	YRS R922Y (C50Y2)	5.8	6.5
86-37	Inc. C37	5.2	5.8
1204(C)	C37 x $C37R_z$	5.2	5.8
Y141	YRS Y941 (C91)	5.5	6.5
Y148	YRS Y948 (C93)	6.0	6.7
Y139	YRS Y939 (C39)	5.8	6.7
R139C7	RZM R039C6 (C39R)	5.7	6.5
Y147	YRS Y947 (C47)	6.2	6.5
R147C7	RZM R047C6 (C47R)	6.0	7.0
R107	RZM R007	5.8	6.7
R108	RZM R008	6.0	7.2
Z010	Inc. 2n Polish-C	6.8	7.8
Z120	RZM Z010H12	6.2	7.3
Z012	Inc. 2n Polish-2	7.2	7.8
Z122	RZM Z012H12	5.5	6.5
Z014	Inc. 2n Polish-4	7.5	7.8
Z124	RZM Z014H12	6.3	7.3
MM,S^f,A:aa POPULATIONS & LINES			
1905	YRS popn-905	5.2	6.2
5747	popn-747aa x A	4.8	5.7
0910	RZM popn-910 ($747R_z$)	5.0	5.8
R129	RZM (747*3 x PI206407)	5.2	5.8
0911	RZM popn-911	5.5	6.2
0913-#(C)	S_1(RZM popn-913)	5.3	5.8
1913	RZM popn-913	5.2	5.8
1915	RZM popn-915	5.0	5.8

Variety	Description	CT Grade 1st Rating	CT Grade 2nd Rating
MM,S^f,A:aa POPULATIONS & LINES (cont.)			
1915-#(C)	S_1(RZM popn-915)	5.2	5.8
0909- 7	Inc. 8909A- 7	5.3	6.3
0909-34	Inc. 8909A-34	5.2	5.8
0909-37	Inc. 8909A-37	5.8	6.5
1907-14	RZM 9907-14	6.3	7.3
1908- 7	RZM 9908- 7	6.0	7.3
1909-13	RZM 9909-13	5.2	6.0
1911- 4	Inc. 9911- 4	5.3	6.0
1911-12	Inc. 9911-12	5.2	6.0
1911-14	Inc. 9911-14	5.3	6.0
1911-50	Inc. 9911-50	5.2	6.3
1912- 3	Inc. 9912- 3	5.5	6.2
1912-11	Inc. 9912-11	5.5	6.2
1913- 5	Inc. 9911H49- 5	5.7	6.5
1913-18	Inc. 9911H49-18	5.2	6.2
1913-22	Inc. 9911H49-22	5.5	6.3
1913-25	Inc. 9911H49-25	5.2	6.3
0911-1	9911-1aa x A	5.7	6.5
0911-4(B)	9911-4aa x A	5.2	6.2
0913-6	9911H49-6aa x A	5.2	5.8
0913-9	9911H49-9aa x A	5.5	6.3
0915- 1	9903- 1aa x 9913	5.2	5.8
0915- 4	9903- 4aa x 9913	5.3	5.8
0915- 6	9903- 6aa x 9913	5.2	5.8
0915- 7	9903- 7aa x 9913	5.3	5.8
0915-16	9903-16aa x 9913	5.2	6.0
0915-22	9903-22aa x 9913	5.0	5.8

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1992
(cont.)

Variety	Description	CT Grade[1] 1st Rating	2nd Rating
MM,S[f],A:aa POPULATIONS & LINES (cont.)			
0915-23	9903-23aa x 9913	5.0	5.8
0915-24	9903-24aa x 9913	5.0	5.8
0915-27	9903-27aa x 9913	5.0	6.0
0915-34	9903-34aa x 9913	4.8	6.0
0915-46	9903-46aa x 9913	5.5	6.0
0911-24	9911-24aa x A	5.5	6.3
N103(C603)	NR 0204-1,2,3P	7.2	8.8
N144-1(C)	NR 0204-1-#(C)	6.3	7.5
N144-2(C)	NR 0204-2-#(C)	6.2	7.5
N144-3(C)	NR 0204-3-#(C)	6.0	7.0
mm,S[f],A:aa POPULATIONS			
0790	popn-C790aa x A	5.2	6.0
1890	RZM 0790H124	5.5	6.2
1887	RZM popn-887	5.7	6.5
1859	NB popn-859	5.5	6.2
1859R	RZM popn-859	5.0	5.8
1864	RZM popn-864	6.0	6.3
1867	NB popn-867	6.0	6.5
1867R	RZM popn-867	5.5	5.8
1866	RZM popn-866	5.3	6.5
1865	RZM popn-865	6.3	7.0
1865-#(C)	S_1 popn-865	6.5	7.2
US 33		5.6	6.7
US 41		5.2	6.1

Variety	Description	CT Grade 1st Rating	2nd Rating
mm,S[f] LINES			
87-309	Inc. C309	6.5	7.3
83-718	Inc. C718	4.8	5.8
88-790-68	Inc. C790-68	6.2	7.2
1790- 6	C790- 6	5.8	6.7
1790-15	C790-15	5.7	6.5
1790-54	C790-54	5.7	6.0
91-762-17	Inc. C762-17	4.5	5.3
91-762-17CMS	C762-17CMS x C762-17	4.5	5.3
91-767-46	Inc. C767-46	5.3	6.5
F82-562	Inc. C562	4.8	5.8
F82-546	Inc. C546	4.8	5.8
0796-43	Inc. C796-43	4.8	6.0
0766-62	Inc. C766-62	5.5	6.5
1855-24	RZM 9855-24-4	6.7	7.5
1855-59	RZM 9855-59-1	6.0	6.8
1852- 7	RZM 0852- 7	6.8	7.2
1852-52	RZM 0852-52	5.8	7.2
0864-1	9864-1aa x A	5.7	6.2
0722	Inc. T-O 9722	5.8	6.8
88-790-68H26	C309CMS x C790-68	5.3	6.3
87-309H37	C306CMS x C309	5.3	6.3
87-309H3	C562-CMS x C309	5.2	5.8
F82-546H3	C562CMS x C546	5.0	5.8

[1]Mean of 3 replications.

TEST 392. BOLTING AND PERFORMANCE OF HYBRIDS, SALINAS, CA., 1992

16 entries x 8 replications, RCB (equalized)
1-row plots, 16 ft. long

Planted: November 1, 1991
Harvested: September 17, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.	Root Rot %
HM-2B	10/23/91 Hill-MH	20120	65.75	15.33	0.0	0.5	1.8	3.2	1.5	149	1.0
9BG6381	Betaseed	18190	58.69	15.49	0.0	0.9	1.8	2.5	1.8	152	0.0
H88243	10/24/91 Spreck	18040	57.74	15.59	0.0	0.0	1.8	3.6	2.6	157	0.0
89C58-02	10/23/91 Holly	17930	58.92	15.23	0.0	0.9	1.4	3.4	1.4	152	0.0
HM-1B	10/23/91 Hill-MH	17870	64.75	13.89	0.0	1.0	1.4	3.1	2.1	144	0.0
H90107	10/24/91 Spreck	17780	60.20	14.76	0.0	0.0	0.4	3.4	1.6	154	0.0
0BG6324	Betaseed	17380	59.07	14.78	0.0	0.0	0.9	2.4	1.3	149	0.0
91C143-027	10/23/91 Holly	17290	56.70	15.24	0.0	1.8	1.8	3.5	1.4	149	0.0
91-89C58-07	10/23/91 Holly	17140	55.36	15.46	0.0	0.9	2.3	3.6	1.4	150	0.0
91-89C58-02	10/23/91 Holly	16920	54.98	15.41	0.0	0.5	2.4	3.0	1.9	147	0.0
G6217	Betaseed	16720	57.81	14.46	0.0	0.0	0.0	2.2	1.4	154	0.0
H86558	10/24/91 Spreck	16670	56.35	14.82	0.0	0.0	0.0	2.6	1.6	150	0.5
HM-3B	10/23/91 Hill-MH	16310	55.95	14.59	0.0	0.9	1.4	3.3	1.8	149	0.0
SS-NB3	10/24/91 Spreck	16180	54.95	14.74	0.0	0.0	0.5	3.5	2.1	149	0.0
H90349	10/24/91 Spreck	16130	53.15	15.20	0.0	0.0	0.5	3.8	1.6	149	0.0
US H11	L786442	15750	55.65	14.21	0.0	0.5	0.0	4.1	1.4	145	0.0
Mean		17277	57.88	14.95	0.0	0.5	1.1	3.2	1.7	150	0.1
LSD (.05)		1303.8	4.16	0.53	---	1.2	2.0	0.4	0.5	8.1	0.6
C.V. (%)		7.6	7.26	3.56	---	242.7	178.9	12.8	30.4	5.5	633.3
F value		5.3**	5.32**	7.00**	---	1.7NS	1.3NS	13.4**	3.9**	1.3NS	1.7*

Note: Bolting was unusually light in 1991-92 due to unusually warm winter. Powdery mildew was not initially controlled, then after tests were scored for PM, were sprayed with Bayleton. Black aphids were a periodic problem and were sprayed three times. Virus yellows (BYV and BWYV) were epidemic by late spring. A few plants were infected with curly top. Rust was severe in late winter and early spring on highly susceptible entries. There was no evidence of rhizomania in the block 1 November planted tests.

TEST 192. EVALUATION/SELECTION FOR RESISTANCE TO BOLTING, SALINAS, CA., 1991-92

12 entries x 15 replications/ 9 entries x 30 replications
1-row plots, 18 ft. long

Planted: November 1, 1991
Not Harvested For Yield

Variety	Description	Beets 100' No.	% Bolting 06/01	% Bolting 07/07	% Bolting 08/27	Powdery Mildew Mean	Rust Score Mean
1865	RZM 0865	138	2.2	14.0	19.6	2.8	2.2
1864	RZM 0864	155	1.2	3.4	8.2	2.1	1.5
1867	NB 9867m	157	0.2	0.5	0.5	2.6	2.4
1867R	RZM 0867	161	2.3	5.3	6.7	2.7	1.8
1859	NB 9859m	155	0.0	0.2	0.7	4.4	2.6
1859R	RZM 0859	152	0.0	1.0	1.5	3.7	1.7
N151	NR N902-3H46	147	5.3	11.1	14.1	3.2	2.0
N152	NR-RZM 0204-2	148	4.3	19.5	20.8	5.1	2.1
R076	RZM R976	137	4.9	16.2	18.4	1.9	2.1
R078	RZM R978C2	138	2.1	7.5	8.8	2.1	1.7
R080	RZM R980	139	0.1	4.6	6.1	1.9	1.6
R070	Inc. R971-R980	152	3.1	8.7	11.3	2.1	1.8
Y131-43	BYR Y931-43	144	0.0	3.1	4.9	1.2	1.3
Y131-89	BYR Y931-89	142	0.0	2.1	2.6	2.2	1.2
R139C7	RZM R039C6	146	2.2	15.2	20.2	1.4	1.6
Y139	BYR Y939	133	0.3	3.9	6.4	1.0	1.1
R147C7	RZM R047C6	139	0.3	3.5	5.6	2.5	1.7
Y147	BYR Y947	155	0.1	2.3	4.8	1.5	1.6
Z120	RZM Z010H12	137	3.4	10.8	13.1	2.7	3.0
1913	RZM 0913	132	0.6	0.8	1.1	1.8	3.3
1915	RZM 0915	126	0.3	0.9	1.2	2.0	2.5

TEST 892. BOLTING EVALUATION OF LINES, SALINAS, CA., 1991-92

160 entries x 3 replications
1-row plots, 18 ft. long

Planted: November 1, 1991
Not Harvested For Yield

Variety	Description	Beets/ 100' No.	% Bolting 06/01	% Bolting 07/07	% Bolting 08/28	Powdery Mildew Mean	Rust Score Mean
Block 1							
MM,O.P. lines							
SP 7622-0	L80466 (8/87)	109	59.1	81.7	85.9	3.9	2.0
Y009	Inc. US 22/3	128	70.2	77.7	79.1	4.8	3.2
768	Inc. 868 (US 75)	126	0.0	2.9	1.5	4.1	2.8
U86-37	C37, 86443	133	1.4	0.0	1.4	3.4	1.8
R979	Inc. R879	139	16.3	16.3	17.6	3.3	1.3
R079	RZM R979	130	15.5	19.9	19.9	3.4	1.0
R028	RZM 9221	137	16.2	23.2	28.4	4.2	1.8
R128	RZM 0271-#	141	17.5	23.9	19.7	3.6	1.7
R030	RZM 9225	139	5.3	13.4	14.7	2.3	2.3
R130	RZM R030	143	7.5	23.1	29.9	2.2	2.2
R121	BYR R921,R924,R925	139	2.5	6.8	8.1	2.5	1.8
Y954	Inc. Y854	143	2.6	5.0	6.3	1.7	1.5
R080 (Sp)	Inc. R980	132	0.0	5.7	5.6	1.9	1.5
R080 (Iso)	RZM R980	141	1.4	9.5	10.9	2.2	2.7
Y054 (Iso)	BYR-ER-PMR Y854	141	0.0	0.0	0.0	1.4	1.8
Y054-2	Inc. Y854-2	145	0.0	2.6	2.6	1.6	1.8
Block 2							
Y054-12	Inc. Y854-12	139	0.0	0.0	2.7	1.9	1.8
Y054-23	Inc. Y854-23	146	0.0	0.0	2.8	1.8	2.5
Y054-38	Inc. Y854-38	143	0.0	0.0	0.0	1.7	2.0
Y054-63	Inc. Y854-63	145	0.0	0.0	0.0	2.7	2.7

TEST 892. BOLTING EVALUATION OF LINES, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Beets/ 100'	% Bolting			Powdery Mildew	Rust Score
		No.	06/01	07/07	08/28	Mean	Mean
Block 2 (cont.)							
Y054-85	Inc. Y854-85	141	0.0	0.0	0.0	2.9	3.0
R122R3	RZM R022 R2	152	35.4	53.6	54.9	4.0	2.2
R122Y2	BYR R922Y,S;R918	154	13.2	24.1	25.2	2.6	1.7
R970	RZM R871-R879,8244	146	5.3	19.1	19.1	2.5	2.7
R070	Inc. R971-R980	135	2.7	8.1	8.1	2.7	2.8
U86-46/2	C46/2, 86342	143	0.0	0.0	1.2	1.9	2.0
1/846 (Sp)	Inc. Y746	133	0.0	1.3	2.8	1.8	1.2
R978C2	RZM R878	143	9.2	17.1	17.1	1.6	2.5
R078	RZM R978C2	137	2.6	6.6	6.6	2.1	2.0
N012	NR-RZM 9201,2	137	14.9	24.3	25.6	2.6	2.2
F86-31/6	86263,Inc. C31/6	139	0.0	1.3	1.3	1.7	1.7
Y931	Inc. Y731	135	0.0	4.2	4.2	2.0	1.5
Block 3							
R971	RZM R871	141	1.2	9.0	6.4	2.9	2.5
R076	RZM R976	132	2.7	18.3	18.3	1.9	2.8
R176-43-#(C)	Y931-43 x R076	137	0.0	0.0	1.3	1.7	3.3
R176-89-#(C)	Y931-89 x R076	133	4.2	11.2	11.2	1.9	2.2
Y931-43	Inc. Y731-43	128	0.0	0.0	0.0	1.9	2.2
Y131-43	BYR Y931-43	133	0.0	0.0	0.0	1.9	1.7
Y931-89	Inc. Y731-89	135	0.0	0.0	0.0	2.5	1.7
Y131-89	BYR Y931-89	146	0.0	2.6	3.8	2.2	1.3
F86-91	Inc. C91 86019	139	1.4	4.2	6.9	0.9	1.8
Y141	BYR Y941	143	2.6	3.9	5.2	1.0	1.3
Y148	BYR Y948	145	2.6	6.5	9.1	1.7	1.0
Y049	BYR-ER-PMR Y849	141	1.3	5.1	8.0	1.0	0.8

TEST 892. BOLTING EVALUATION OF LINES, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Beets/ 100'	% Bolting			Powdery Mildew	Rust Score
		No.	06/01	07/07	08/28	Mean	Mean
Block 3 (cont.)							
Y156	BYR Y94\56	146	5.0	7.3	8.5	1.6	2.2
Y057	BYR-ER-PMR Y857	143	0.0	5.2	7.8	2.5	1.5
Y039	Inc. Y939	132	0.0	6.4	6.4	1.0	1.7
Y139	BYR Y939	135	0.0	1.3	1.3	1.2	2.0
Block 4							
US H11	L784442	146	0.0	0.0	0.0	4.5	1.8
R839-6	RZM R739-6	132	2.9	4.3	4.3	1.6	2.3
R039C5	Inc. R939C5	137	1.4	19.1	27.4	2.1	2.2
R139C7	RZM R039C6	145	3.8	23.1	25.6	2.0	2.0
Y047	Inc. Y947	130	2.9	4.3	4.3	2.4	1.3
Y147	BYR Y947	154	1.2	4.8	6.0	2.3	1.7
R047C5	Inc. R947C5	137	0.0	8.2	14.9	3.1	1.5
R147C7	RZM R047C6	152	0.0	3.8	3.8	3.3	2.2
R104	RZM R004	139	44.3	55.1	60.4	2.4	3.2
R105	RZM R005	135	0.0	10.7	20.5	3.1	2.5
R106	RZM R006	141	6.4	26.2	39.4	3.7	1.8
R107	RZM R007	137	1.3	7.9	9.2	3.2	2.3
R108	RZM R008	137	2.9	12.2	13.5	2.7	2.3
R119	RZM 901008,89141	146	19.1	28.6	29.8	2.7	2.2
R020(Sp)	Inc. R920	130	18.9	38.8	38.8	2.8	2.5
R120	RZM R020	145	10.3	18.1	19.3	2.5	2.5

TEST 892. BOLTING EVALUATION OF LINES, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Beets/ 100'	% Bolting			Powdery Mildew	Rust Score
		No.	06/01	07/07	08/28	Mean	Mean
Block 5							
9101	Inc. 8101 (C11T)	126	0.0	1.5	1.5	2.1	1.7
9102	Inc. 8102 (C12T)	124	3.0	9.0	10.4	2.3	2.3
Z010	Inc. P1,...P7	109	3.0	24.8	26.8	3.3	2.3
Z010H12	9912aa x P#(C)	128	1.4	8.8	11.6	3.1	3.0
Z120	RZM Z010H12	132	4.2	12.9	17.3	3.6	3.3
Z011	Inc. Polish #1	109	4.8	22.7	31.2	4.1	2.5
Z012	Inc. P_2	115	4.8	9.6	9.6	3.3	2.8
Z012H12	9912aa x P_2	132	4.3	14.1	15.5	3.1	3.2
Z122	RZM Z012H12	141	6.7	9.7	9.7	3.0	3.7
Z013	Inc. Polish #3	128	7.2	20.3	30.7	3.2	3.0
Z014	Inc. P4	119	1.6	6.3	9.5	2.1	2.8
Z014H12	9912aa x P4	128	1.3	5.9	10.4	2.7	3.0
Z124	RZM Z014H12	122	0.0	3.2	6.0	3.1	3.8
Z017	Inc. Polish #7	119	12.2	33.5	41.2	3.0	2.5
U86-37	C37, 86443	139	0.0	0.0	0.0	3.1	2.0
Sp 7622-0	L80466 (8/87)	141	48.6	76.3	77.5	2.7	2.5
Block 6							
MM,S^f,A:aa lines and populations							
1905	BYR 9905 (A,aa)	139	0.0	4.0	4.0	1.8	1.7
1914	RZM 0914	139	2.6	7.9	7.9	2.5	1.8
5747	4747aa x A	137	0.0	1.3	1.3	3.3	2.3
9910(Sp)	8910aa x A (C)	141	1.3	2.6	2.6	3.7	3.2
9910H47	5747aa x 8910	133	0.0	1.4	1.4	3.7	3.2
0910	RZM 9910H47 (A,aa)	143	5.1	10.2	10.2	3.3	2.8
R029	RZM 9223	133	14.7	19.8	19.8	2.7	2.7
R129	RZM 0281-#	141	8.4	11.4	12.9	3.2	1.8

TEST 892. BOLTING EVALUATION OF LINES, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Beets/ 100' No.	% Bolting 06/01	% Bolting 07/07	% Bolting 08/28	Powdery Mildew Mean	Rust Score Mean
Block 6 (cont.)							
R031	RZM 9226	132	38.2	56.6	62.1	3.9	2.8
R131	RZM R031	139	43.7	73.2	77.7	4.2	3.7
N042	NR-RZM 9205,7,8	130	0.0	4.6	4.6	4.6	3.3
9903	YR-ER-PMR 7903 (A,aa)	133	0.0	0.0	0.0	2.9	2.8
8909(Sp)	7909,7239aa x A	130	0.0	0.0	4.4	2.7	3.2
9912	RZM 8908,09,10,11aa x 8908,09,10,11A (C)	126	8.6	10.0	10.0	3.4	3.5
9911(Sp)	8911aa x A	135	1.3	1.3	2.6	2.5	3.0
US H11	L78442	139	0.0	0.0	0.0	3.7	2.8
Block 7							
0911(Sp)	9911(Iso)aa x A	137	1.4	5.3	5.3	3.6	2.5
0911(Iso)	RZM 9911 (A,aa)	148	1.3	2.4	3.8	2.4	3.0
0913(Iso)	RZM 9911H49 (A,aa)	139	0.0	0.0	1.3	2.2	3.0
0913(Sp)	9911H49aa x A	137	0.0	4.1	4.1	2.6	2.5
1913	RZM 0913 (Sp) (A,aa)	137	0.0	1.3	2.7	2.7	2.8
0915	9903aa x 9911H49,9911	139	1.3	2.7	2.7	2.7	2.5
1915	RZM 0915 (A,aa)	130	0.0	0.0	0.0	1.9	2.7
0906-4	Inc. 8906A-4	139	1.4	13.5	14.7	4.0	4.5
0906-7	Inc. 8907A-7	139	1.5	3.0	4.3	6.1	4.0
0909-7	Inc. 8909A-7	145	18.3	41.8	41.8	4.0	2.5
0909-34	Inc. 8909A-34	137	4.2	16.2	17.4	2.1	1.8
0909-37	Inc. 8909A-37	139	2.7	5.4	6.7	1.9	2.7
0909-48	Inc. 8909A-48	133	4.1	15.2	16.6	4.5	5.0
1907-14	RZM 9907-14	139	32.0	41.3	44.0	4.4	4.7
1908-7	RZM 9908-7	146	2.5	2.5	4.9	4.4	3.5
1909-13	RZM 9909-13	139	4.1	5.6	5.6	7.2	4.7

TEST 892. BOLTING EVALUATION OF LINES, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Beets/ 100'	% Bolting			Powdery Mildew	Rust Score
		No.	06/01	07/07	08/28	Mean	Mean
Block 8							
1911- 4	Inc. 9911- 4 (A,aa)	141	0.0	0.0	1.3	2.9	3.5
1911-12	Inc. 9911-12 (A,aa)	135	0.0	0.0	0.0	3.6	3.3
1911-14	Inc. 9911-14 (A,aa)	146	2.5	5.1	5.1	3.1	2.7
1911-50	Inc. 9911-50 (A,aa)	145	2.8	4.0	4.0	2.9	2.7
1912- 3	Inc. 9912- 3 (A,aa)	143	0.0	1.5	1.5	4.0	3.7
1912-11	Inc. 9912-11 (A,aa)	141	1.4	5.4	6.7	4.4	3.7
1913- 5	Inc. 9911H49- 5 (A,aa)	141	0.0	0.0	0.0	2.6	2.8
1913-18	Inc. 9911H49-18 (A,aa)	145	0.0	1.2	3.9	2.4	3.2
1913-22	Inc. 9911H49-22 (A,aa)	141	0.0	0.0	0.0	1.6	2.2
1913-25	Inc. 9911H49-25 (A,aa)	135	0.0	0.0	2.9	1.9	1.8
Monogerm S^f,A:aa populations							
0790	8790-S_1(C)aa x A	143	0.0	0.0	2.3	2.3	1.8
1890	RZM 0790H124 (A,aa)	143	0.0	1.2	1.2	4.3	3.3
8776 (Iso)	NB 6776 (A,aa)	150	0.0	0.0	0.0	3.3	2.0
1876	RZM 0876	132	1.3	1.3	1.3	3.5	2.5
0787	BYR-ER-PMR 8787	143	0.0	0.0	0.0	3.5	2.0
1887	RZM 0887	148	0.0	1.2	2.5	4.6	3.0
Block 9							
0859	RZM 9859H6	148	0.0	0.0	0.0	4.6	3.2
1859	NB 9859m (A,aa)	156	1.2	1.2	2.4	5.9	3.0
1859R	RZM 0859 (A,aa)	148	0.0	0.0	0.0	5.1	2.3
8767 (Iso)	NB 6767 (A,aa)	156	0.0	0.0	0.0	3.1	2.0
0864	9864aa x A	145	0.0	10.3	11.5	3.5	2.5
1864	RZM 0864 (Sp) (A,aa)	152	3.7	10.9	10.9	3.9	2.8
0867	RZM 9867H67	141	1.3	2.7	5.3	3.6	3.0
1867	NB 9867m (A,aa)	135	0.0	0.0	0.0	3.5	3.8

TEST 892. BOLTING EVALUATION OF LINES, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Beets/ 100' No.	% Bolting 06/01	% Bolting 07/07	% Bolting 08/28	Powdery Mildew Mean	Rust Score Mean
Block 9 (cont.)							
1867R	RZM 0867 (A,aa)	143	0.0	3.8	6.5	4.1	3.5
0755	BYR-ER-PMR 8755	152	0.0	0.0	0.0	3.4	2.8
0866	RZM 9866H80	148	0.0	2.6	2.6	4.1	3.0
1866	RZM 0866 (A,aa)	146	0.0	7.7	9.0	7.2	3.3
9855	RZM 8855	150	5.1	7.3	8.7	3.0	3.7
0865	RZM 9865	141	6.1	13.9	16.3	4.3	3.7
1865	RZM 0865 (A,aa)	150	1.3	16.1	21.0	4.1	3.7
0722	Inc. T-O 9722-#	132	0.0	0.0	0.0	2.6	2.3
Block 10							
NR Lines and Selections							
N801(A)(Sp)	Inc. B883	148	100.0	100.0	100.0	6.7	2.3
N103	NR 0204-1,2,3P	145	13.9	89.6	96.3	7.1	2.0
N144-1-#(C)	NR 0204-1-# x	133	1.3	1.3	6.8	6.5	3.2
N144-2-#(C)	NR 0204-2-# x	145	1.2	11.4	13.9	5.7	2.8
N144-3-#(C)	NR 0204-3-# x	135	2.7	15.2	27.2	5.7	3.3
N148-#(C)	NR N902-3H46 x	141	5.1	15.4	16.7	4.7	3.3
N149-#(C)	NR N902-5H45 x	141	1.4	5.3	5.3	3.9	4.2
N150-#(C)	NR N902-3H46aa x 0913	126	0.0	4.2	7.3	3.7	3.8
N151	NR N902-3H46 (A,aa)	139	5.2	10.6	12.0	4.7	2.8
N152	NR-RZM 0204-2 (C)	135	4.3	24.9	28.1	6.1	3.5
1227-#(C)	0241-40-# x	139	0.0	2.7	6.7	4.9	3.2
1230-#(C)	0244-10-# x	135	0.0	4.1	4.1	3.1	3.2
1231-#(C)	0244-12 x	143	0.0	1.3	1.3	3.3	3.5
N112-#(C)	NR-RZM N012 x	137	1.2	17.6	22.5	2.4	2.8
N142-#(C)	NR-RZM N042 x	143	2.5	7.8	11.7	5.7	3.8
N172-#(C)	NR-RZM N072 x	128	2.8	10.0	12.9	4.8	3.0

TEST 892. BOLTING EVALUATION OF LINES, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Beets/ 100'	% Bolting			Powdery Mildew	Rust Score
		No.	06/01	07/07	08/28	Mean	Mean
Mean		138.2	5.7	11.6	13.3	3.2	2.6
LSD (.05)		16.9	7.4	11.0	10.7	1.2	1.2
C.V. (%)		7.6	81.1	58.8	50.4	22.7	29.4
F value		1.9**	24.6**	20.6**	23.7**	9.5**	3.2**

TEST 592. BOLTING EVALUATION OF SELF-FERTILE LINES, SALINAS, CA., 1991-92

50 entries x 3 replications
1-row plots, 18 ft. long

Planted: November 1, 1991
Not Harvested For Yield

Variety	Description	Beets/ 100'	% Bolting			Powdery Mildew	Rust Score
		No.	06/01	07/07	08/27	Mean	Mean
F82-546H3	82460	137	0.0	0.0	0.0	4.0	3.0
87-309H37	87242	143	0.0	1.3	3.8	3.7	1.8
87-309H3	87671	133	0.0	1.4	1.4	5.2	2.3
88-790-68H26	88189	143	0.0	3.8	7.7	3.7	1.5
88-790-68H92	88190	135	0.0	0.0	0.0	3.3	2.2
88-790-68H37	88191	137	0.0	1.3	2.7	2.1	1.0
83-718	83246	135	0.0	0.0	0.0	2.3	1.8
F82-562	82196	135	0.0	0.0	0.0	3.9	2.7
F82-562HO	82195	143	0.0	0.0	0.0	4.2	3.0
F82-546	82372	135	0.0	0.0	0.0	5.0	3.0
87-309	87672	143	0.0	0.0	0.0	4.9	3.2
87-309CMS	87670	137	0.0	1.5	1.5	5.9	3.2
88-790-68	88192	124	0.0	0.0	0.0	1.3	2.2
88-790-68CMS	88187	137	0.0	1.3	5.4	1.3	1.8
89-762-17	89121	133	0.0	0.0	0.0	0.9	1.0
91-762-17	10/22/91	137	0.0	0.0	0.0	1.0	1.3
91-762-17CMS	10/22/91	143	0.0	0.0	0.0	1.8	1.5
9807	T-O 8807-# (C306)	135	0.0	0.0	0.0	1.7	2.5
0833	Inc. T-O 9833-#	139	0.0	0.0	0.0	3.1	3.3
0767-46	Inc. T-O 9767-46-#	141	0.0	0.0	0.0	4.0	2.5
91-767-46	10/22/91	145	0.0	0.0	1.3	3.6	2.3
0796-43	Inc. 5796-43	139	0.0	0.0	0.0	3.1	4.7
1790- 6	8790- 6 x	126	0.0	0.0	0.0	1.6	1.0
1790-15	8790-15 x	135	0.0	0.0	0.0	1.3	2.0
1790-23	8790-23 x	146	0.0	1.2	1.2	1.8	2.7

TEST 592. BOLTING EVALUATION OF SELF-FERTILE LINES, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Beets/ 100'	% Bolting			Powdery Mildew	Rust Score
		No.	06/01	07/07	08/27	Mean	Mean
1790-47	8790-47 x	137	0.0	0.0	0.0	0.9	1.3
1790-54	8790-54 x	141	0.0	0.0	0.0	0.9	1.2
1790-55	8790-55 x	100	0.0	1.9	3.5	1.7	1.7
1790-61	8790-61 x	113	0.0	0.0	0.0	2.5	1.5
1790-71	8790-71 x	122	1.7	0.0	3.1	3.1	3.7
1852- 7	RZM 0852- 7	141	0.0	0.0	0.0	2.8	5.7
1852-52	RZM 0852-52	132	0.0	0.0	0.0	3.0	4.0
1855-24	RZM 9855-24-4	150	0.0	0.0	2.5	2.5	4.8
1855-59	RZM 9855-59-1	113	0.0	0.0	0.0	4.1	1.5
1852-3-5(C)	RZM 9852-3-5-# x	109	0.0	0.0	0.0	3.2	3.7
1852-41-2-1	RZM 9852-41-2-1 x	50	0.0	0.0	0.0	2.8	6.2
1852-46-4(C)	RZM 9852-46-4-# x	128	0.0	0.0	0.0	2.5	4.3
1855-21-5(C)	RZM 9855-21-5-# x	104	0.0	0.0	0.0	3.7	2.9
1855-22-2(C)	RZM 9855-22-2-# x	117	0.0	0.0	0.0	2.7	4.2
1855-48-1-1	RZM 9855-48-1-1 x	93	0.0	0.0	0.0	4.1	3.0
1855-48-2-1	RZM 9855-48-2-1 x	74	0.0	0.0	0.0	3.3	4.8
1855-56-3(C)	RZM 9855-56-3-# x	132	0.0	0.0	0.0	3.7	6.3
1855-56-4-1	RZM 9855-56-4-1 x	63	0.0	0.0	0.0	2.4	5.8
1855-56-6(C)	RZM 9855-56-6-# x	104	0.0	0.0	0.0	2.7	6.2
0766-62	Inc. 9766-62	126	0.0	0.0	0.0	5.3	3.2
9554	Inc. 5554 (NB4)	132	0.0	0.0	1.4	3.9	2.8
9554H1	8502HO x 5554 (NB1 x NB4)	126	0.0	0.0	3.1	4.0	2.7
1502	Inc. 1502 (1971)	72	2.1	6.5	6.5	4.7	4.0
1512	Inc. 6512 (NB6)	135	0.0	0.0	0.0	4.3	3.8
9600(A)	Inc. 8600 (Annual)	113	100.0	100.0	100.0	4.4	2.8
Mean		125.3	2.1	2.4	2.9	3.1	3.0
LSD (.05)		19.1	1.1	2.2	2.9	1.2	1.3
C.V. (%)		9.4	31.7	57.6	60.8	23.2	27.2
F value		10.7**	1389.9**	311.7**	192.2**	9.6**	9.5**

TEST 292. BOLTING EVALUATION OF HYBRIDS, SALINAS, CA., 1991-92

56 entries x 2 replications
1-row plots, 16 ft. long

Planted: November 1, 1991
Harvested: September 17, 1992

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.
R080H30	C790-15aa x R980	19780	67.90	14.60	0.0	0.0	2.0	0.9	1.3	133
1913-18H20	87-309H3 x 9911H49-18	18970	65.80	14.43	0.0	0.0	0.0	2.4	2.5	122
R080H33	C790-54aa x R980	18830	64.60	14.65	0.0	0.0	0.0	1.5	1.0	139
R080H34	8790-55aa x R980	18440	61.84	14.85	0.0	0.0	2.3	1.5	1.0	125
R080H29	C790-6aa x R980	18270	62.54	14.60	0.0	0.0	0.0	1.4	0.8	139
R080H18	88-790-68H26 x R980	18230	61.37	14.88	0.0	0.0	6.2	2.7	1.8	133
Y039H20	87-309H3 x Y939 (C39)	18170	61.65	14.73	0.0	0.0	8.3	2.5	2.3	133
1913-22H20	87-309H3 x 9911H49-22	17860	60.67	14.70	0.0	0.0	0.0	2.5	2.5	136
Y054H20	87-309H3 x BYR Y854 (C54)	17810	63.47	14.05	0.0	0.0	0.0	2.3	1.3	139
4757	Betaseed (1/6/89)	17620	60.90	14.48	0.0	3.7	5.6	1.7	2.3	136
1908-7H20	87-309H3 x RZM 9908-7	17610	61.37	14.32	0.0	0.0	0.0	4.0	1.8	133
SSNB3	Spreckels (1/22/89)	17580	60.44	14.55	0.0	0.0	2.0	2.9	2.8	128
1907-14H20	87-309H3 x RZM 9907-14	17340	58.80	14.75	4.3	10.5	16.8	4.6	4.0	131
R080H38	89-312CMS x R980	17280	64.86	13.30	0.0	0.0	2.5	1.5	2.0	108
1911-50H20	87-309H3 x 9911-50	17250	58.80	14.73	1.9	7.8	4.0	3.7	2.8	142
US H11	L786442	17140	63.00	13.60	0.0	0.0	0.0	3.6	2.3	133
1912-11H20	87-309H3 x 9912-11	17120	60.90	14.05	0.0	1.9	7.6	4.0	3.0	147
R080H40	89-313CMS x R980	17050	64.40	13.25	2.2	11.5	14.0	1.6	2.5	120
R080H8	F82-546H3 x R980	17030	61.60	13.82	0.0	4.2	4.2	2.6	2.5	122
1913-25H20	87-309H3 x 9911H49-25	17000	56.00	15.18	0.0	2.2	2.2	2.0	2.8	122
0913H20	87-309H3 x 9911H49	16970	59.27	14.30	0.0	0.0	0.0	2.8	3.3	128
1911-14H20	87-309H3 x 9911-14	16810	58.57	14.35	0.0	0.0	0.0	3.2	2.5	131
R080H70	C766-62HO x R980	16720	62.54	13.33	0.0	0.0	4.4	3.4	3.0	128
1911-12H20	87-309H3 x 9911-12	16610	55.07	15.07	0.0	0.0	0.0	3.5	2.8	125

TEST 292. BOLTING EVALUATION OF HYBRIDS, SALINAS, CA., 1991-92

(cont.)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.
Y054-23H20	87-309H3 x Y854-23	16470	60.67	13.63	0.0	0.0	0.0	3.0	2.0	142
0909-37H20	87-309H3 x 8909A-37	16410	58.10	14.13	0.0	0.0	2.5	2.7	1.0	117
R080H89	88-790-68CMS x R980	16390	55.78	14.60	5.0	10.0	12.5	1.6	1.5	111
Y931DH20	87-309H3 x Y731/D (C31/6)	16330	58.34	14.00	0.0	0.0	0.0	2.8	1.8	139
Y048H20	87-309H3 x Y948 (C93)	16300	55.07	14.77	0.0	2.0	4.0	2.9	2.3	133
R080H26	87-309CMS x R980	16260	56.94	14.32	6.2	10.4	14.5	2.9	1.0	133
R047C5H20	87-309H3 x R947C5 (C47R)	16250	55.30	14.68	0.0	4.4	6.6	3.4	2.5	125
US H11	L786442	16010	56.00	14.27	0.0	0.0	0.0	3.3	1.5	128
1913-5H20	87-309H3 x 9911H49-5	15930	57.40	13.88	0.0	0.0	2.2	1.9	2.0	128
R080H3	F82-562HO x R980	15930	56.24	14.10	0.0	0.0	0.0	2.7	2.8	139
0906-7H20	87-309H3 x 8906A-7	15910	53.20	14.93	0.0	2.5	5.0	4.3	3.5	125
0913H8	F82-546H3 x 9911H49	15860	54.14	14.65	0.0	0.0	0.0	2.6	3.0	131
R070H20	87-309H3 x R971-R980	15780	54.84	14.30	0.0	6.0	6.0	3.1	3.0	136
Y054-38H20	87-309H3 x Y854-38	15700	54.14	14.50	0.0	0.0	0.0	2.9	1.8	147
Y054-2H20	87-309H3 x Y854-2	15660	57.17	13.70	0.0	1.9	3.6	2.7	2.0	156
0909-48H20	87-309H3 x 8909A-48	15460	54.37	14.23	0.0	0.0	0.0	4.9	4.0	122
Y047H20	87-309H3 x Y947 (C47)	15460	53.20	14.45	0.0	6.5	10.3	3.1	2.0	133
R080H39	89-762-17CMS x R980	15400	59.50	12.93	0.0	0.0	4.4	1.0	2.0	125
0906-4H20	87-309H3 x 8906A-4	15330	55.07	13.93	1.9	0.0	1.9	4.6	3.5	136
0909-7H20	87-309H3 x 8909A-7	15240	52.74	14.45	0.0	2.1	12.5	3.6	2.8	133
R039C5H20	87-309H3 x R939C5 (C39R)	15080	52.97	14.23	1.9	13.4	13.4	2.6	3.3	136
Y054-85H20	87-309H3 x Y854-85	15050	51.57	14.60	0.0	0.0	4.5	3.5	1.8	125
Y846H20	87-309H3 x Y746 (C46/2)	15030	51.80	14.50	0.0	0.0	0.0	2.5	2.5	145
Y054-63H20	87-309H3 x Y854-63	14960	51.57	14.50	0.0	1.8	0.0	3.3	1.5	170
0909-34H20	87-309H3 x 8909A-34	14960	51.80	14.43	0.0	0.0	2.5	2.3	1.8	117
1909-13H20	87-309H3 x RZM 9909-13	14760	51.34	14.40	2.1	2.1	2.1	5.3	3.3	133
Z010H20	87-309H3 x Polish(C)	14720	49.47	15.00	0.0	6.5	13.7	3.9	2.0	136
R080H20	87-309H3 x R980	14660	52.74	13.90	0.0	6.6	4.8	3.2	1.8	133

TEST 292. BOLTING EVALUATION OF HYBRIDS, SALINAS, CA., 1991-92

(cont.)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.
1912-3H20	87-309H3 x 9912-3	14530	52.04	13.98	0.0	2.0	2.0	4.5	3.8	139
WS-PM9	PMR Hilleshog	14510	50.64	14.35	0.0	0.0	0.0	1.8	2.8	131
1911-4H20	87-309H3 x 9911-4	14480	50.58	14.30	0.0	0.0	0.0	3.1	2.5	125
R020H20	87-309H3 x R920 (C94)	13720	57.40	11.95	0.0	10.7	15.5	4.0	2.5	136
Mean		16393	57.47	14.27	0.5	2.3	4.0	2.9	2.3	132.2
LSD (.05)		3388	10.37	1.42	1.8	5.9	9.1	1.2	1.4	24.9
C.V. (%)		10.42	9.10	5.03	202.8	128.4	113.9	21.5	30.5	9.5
F value		1.19NS	1.50NS	1.25NS	3.9**	3.1**	2.2**	5.0**	2.4**	1.3NS

[1]790-68H26 = C309CMS x C790-68; R980 = Y54R$_2$; Y854-# = half-sib families from C54; 8906, 8909, 9911, 9912, 9911H49 = self-fertile, multigerm, A:aa populations or progeny lines.

Note: Bolting was very light in 1991-92 due to unusually warm winter.

TEST 392. BOLTING AND PERFORMANCE OF HYBRIDS, SALINAS, CA., 1992

16 entries x 8 replications, RCB (equalized)
1-row plots, 16 ft. long

Planted: November 1, 1991
Harvested: September 17, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.	Root Rot %
HM-2B	10/23/91 Hill-MH	20120	65.75	15.33	0.0	0.5	1.8	3.2	1.5	149	1.0
9BG6381	Betaseed	18190	58.69	15.49	0.0	0.9	1.8	2.5	1.8	152	0.0
H88243	10/24/91 Spreck	18040	57.74	15.59	0.0	0.0	1.8	3.6	2.6	157	0.0
89C58-02	10/23/91 Holly	17930	58.92	15.23	0.0	0.9	1.4	3.4	1.4	152	0.0
HM-1B	10/23/91 Hill-MH	17870	64.75	13.89	0.0	1.0	1.4	3.1	2.1	144	0.0
H90107	10/24/91 Spreck	17780	60.20	14.76	0.0	0.0	0.4	3.4	1.6	154	0.0
0BG6324	Betaseed	17380	59.07	14.78	0.0	0.0	0.9	2.4	1.3	149	0.0
91C143-027	10/23/91 Holly	17290	56.70	15.24	0.0	1.8	1.8	3.5	1.4	149	0.0
91-89C58-07	10/23/91 Holly	17140	55.36	15.46	0.0	0.9	2.3	3.6	1.4	150	0.0
91-89C58-02	10/23/91 Holly	16920	54.98	15.41	0.0	0.5	2.4	3.0	1.9	147	0.0
G6217	Betaseed	16720	57.81	14.46	0.0	0.0	0.0	2.2	1.4	154	0.0
H86558	10/24/91 Spreck	16670	56.35	14.82	0.0	0.0	0.0	2.6	1.6	150	0.5
HM-3B	10/23/91 Hill-MH	16310	55.95	14.59	0.0	0.9	1.4	3.3	1.8	149	0.0
SS-NB3	10/24/91 Spreck	16180	54.95	14.74	0.0	0.0	0.5	3.5	2.1	149	0.0
H90349	10/24/91 Spreck	16130	53.15	15.20	0.0	0.0	0.5	3.8	1.6	149	0.0
US H11	L786442	15750	55.65	14.21	0.0	0.5	0.0	4.1	1.4	145	0.0
Mean		17277	57.88	14.95	0.0	0.5	1.1	3.2	1.7	150	0.1
LSD (.05)		1303.8	4.16	0.53	---	1.2	2.0	0.4	0.5	8.1	0.6
C.V. (%)		7.6	7.26	3.56	---	242.7	178.9	12.8	30.4	5.5	633.3
F value		5.3**	5.32**	7.00**	---	1.7NS	1.3NS	13.4**	3.9**	1.3NS	1.7*

Note: Bolting was unusually light in 1991-92 due to unusually warm winter. Powdery mildew was not initially controlled, then after tests were scored for PM, were sprayed with Bayleton. Black aphids were a periodic problem and were sprayed three times. Virus yellows (BYV and BWYV) were epidemic by late spring. A few plants were infected with curly top. Rust was severe in late winter and early spring on highly susceptible entries. There was no evidence of rhizomania in the block 1 November planted tests.

TEST 492. BOLTING EVALUATION/SELECTION OF BACKCROSS LINES R176-43 & R176-89, SALINAS, CA., 1991-92

60 entries x 1 replication
1-row plots, 18 ft. long

Planted: November 1, 1991
Harvested: September 17, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.
R176-43- 1	Y931-43 x R076	15737	56.00	14.0	0.0	0.0	0.0	1.4	3.5	133
- 2		13038	45.27	14.4	0.0	0.0	0.0	4.4	2.5	122
- 3		17024	56.94	14.9	0.0	0.0	0.0	1.4	3.5	139
- 4		14791	53.20	13.9	5.0	15.0	20.0	2.8	3.0	111
- 5		15263	52.27	14.6	0.0	8.3	12.5	1.6	4.0	133
- 6		17256	62.07	13.9	0.0	0.0	0.0	1.2	1.0	122
- 7		15065	56.00	13.5	0.0	0.0	0.0	2.6	1.5	133
- 8		16531	65.34	12.6	0.0	0.0	0.0	1.2	5.0	122
- 9		14509	54.14	13.4	0.0	13.6	13.6	0.6	1.5	122
-10		15135	53.67	14.1	0.0	2.6	7.9	2.8	2.0	211
-11		17164	57.40	14.9	0.0	0.0	0.0	2.0	3.0	111
-12		18505	60.67	15.3	0.0	0.0	0.0	1.6	1.5	145
-13		13628	46.67	14.6	0.0	0.0	0.0	1.6	3.0	111
-14		21346	71.87	14.9	0.0	0.0	0.0	1.2	1.5	133
-15		14841	46.67	15.9	0.0	0.0	0.0	1.6	2.5	145
-16		19757	63.94	15.4	0.0	0.0	0.0	2.4	1.0	145
-17		16546	53.20	15.5	0.0	8.3	8.3	1.4	1.5	133
-18		18543	60.20	15.4	0.0	0.0	0.0	2.2	1.5	133
-19		12601	49.42	12.8	0.0	5.6	5.6	2.2	1.5	100
-20		11567	43.49	13.3	18.8	37.5	43.8	3.0	6.0	89

TEST 492. BOLTING EVALUATION/SELECTION OF BACKCROSS LINES R176-43 & R176-89, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.
R176-43-21	Y931-43 x R076	17619	61.60	14.3	0.0	9.1	9.1	1.4	1.5	122
-22		16844	56.33	14.9	0.0	0.0	0.0	2.0	2.0	117
-23		13575	47.14	14.4	0.0	0.0	0.0	3.4	2.5	111
-24		22272	73.51	15.1	0.0	4.3	4.3	2.4	1.5	128
-25		13954	46.67	14.9	0.0	0.0	5.9	2.6	2.0	95
R176-89- 1	Y931-89 x R076	15580	49.94	15.6	3.7	18.5	18.5	2.2	0.5	150
- 2		17809	56.00	15.9	0.0	12.5	16.7	3.2	2.0	133
- 3		15732	49.47	15.9	0.0	0.0	0.0	3.0	1.0	133
- 4		14852	48.54	15.3	37.5	54.2	54.2	3.8	1.5	133
- 5		15435	48.54	15.9	0.0	0.0	0.0	1.4	0.5	145
- 6		15715	56.94	13.8	13.0	21.7	21.7	2.4	3.0	128
- 7		14682	56.47	13.0	0.0	20.8	20.8	2.4	2.5	133
- 8		17682	59.74	14.8	0.0	0.0	0.0	1.2	4.5	117
- 9		16409	56.00	14.6	0.0	20.8	29.2	1.2	2.0	133
-10		17429	66.27	13.1	0.0	0.0	0.0	1.2	1.5	122
-11		16308	59.74	13.6	0.0	4.0	8.0	1.0	1.0	139
-12		20329	77.01	13.2	0.0	0.0	0.0	1.6	3.5	122
-13		10618	44.80	11.9	4.5	36.4	36.4	1.2	3.5	122
-14		17391	63.94	13.6	0.0	0.0	0.0	2.2	2.0	139
-15		17820	60.20	14.8	4.3	30.4	30.4	3.2	3.0	128
-16		20238	69.07	14.6	0.0	9.1	18.2	2.2	4.5	122
-17		15625	56.00	13.9	21.7	65.2	73.9	2.8	1.5	128
-18		20376	68.60	14.9	0.0	0.0	0.0	1.4	3.0	122
-19		18666	61.60	15.1	4.0	44.0	44.0	1.2	2.5	139
-20		16129	56.00	14.4	0.0	0.0	4.0	2.6	1.0	139

TEST 492. BOLTING EVALUATION/SELECTION OF BACKCROSS LINES R176-43 & R176-89, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.
R176-89-21	Y931-89 x R076	17270	54.14	16.0	0.0	0.0	0.0	3.2	2.0	139
-22		18978	63.47	15.0	0.0	0.0	0.0	2.2	1.5	122
-23		16891	54.14	15.6	0.0	0.0	0.0	3.0	2.0	133
-24		14836	51.34	14.4	0.0	0.0	0.0	1.0	1.0	128
-25		20514	69.07	14.9	0.0	0.0	4.0	4.0	6.0	139
-26		14671	54.14	13.5	34.8	73.9	95.7	2.8	3.5	128
-27		17881	60.20	14.9	4.2	29.2	50.0	1.4	1.0	133
-28		19529	61.60	15.9	0.0	28.0	28.0	4.6	1.5	139
-29		20159	64.40	15.6	0.0	0.0	8.0	1.0	1.0	139
-30		15719	50.87	15.5	0.0	12.5	12.5	4.2	2.5	133
-31		19803	72.81	13.6	4.8	23.8	23.8	1.6	1.0	117
-32		15896	60.67	13.1	0.0	0.0	0.0	3.2	1.0	139
-33		15849	56.00	14.1	36.4	45.5	45.5	3.8	1.5	122
-34		17759	58.80	15.1	0.0	26.1	34.8	3.0	1.5	128
-35		17419	54.60	15.9	0.0	4.5	9.1	1.8	1.5	122

TEST 692. BOLTING EVALUATION/SELECTION OF LINES WITHIN POPN-865, SALINAS, CA., 1991-92

60 entries x 1 replication
1-row plots, 18 ft. long

Planted: November 1, 1991
Harvested: September 21, 1992

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.
1865- 1	0865	7527	33.60	11.2	0.0	0.0	0.0	3.6	1.5	117
- 2		12859	44.80	14.4	0.0	0.0	0.0	6.4	2.0	106
- 3		7981	28.00	14.3	0.0	0.0	0.0	3.0	2.5	128
- 4		8662	27.67	15.6	5.0	5.0	5.0	2.4	3.0	111
- 5		12635	43.87	14.4	0.0	0.0	0.0	2.6	4.0	117
- 6		9289	29.87	15.6	0.0	0.0	0.0	3.2	3.0	128
- 7		4744	19.77	12.0	0.0	16.7	16.7	3.2	4.0	100
- 8		8821	34.59	12.8	0.0	0.0	5.0	4.0	3.0	111
- 9		8578	27.67	15.5	3.8	19.2	23.1	3.0	3.0	145
-10		12153	39.20	15.5	0.0	0.0	0.0	3.8	2.5	133
-11		9824	33.08	14.9	19.0	76.2	81.0	5.2	2.0	117
-12		6417	22.05	14.6	0.0	20.0	20.0	3.8	2.5	83
-13		11350	35.47	16.0	0.0	0.0	0.0	3.8	3.0	122
-14		11649	37.34	15.6	0.0	21.1	21.1	2.6	4.5	106
-15		7181	26.40	13.6	0.0	0.0	0.0	1.0	3.5	72
-16		11551	35.54	16.3	0.0	0.0	0.0	2.6	4.0	83
-17		9892	31.50	15.7	0.0	0.0	11.8	2.6	4.0	95
-18		12401	42.47	14.6	0.0	3.8	3.8	5.2	5.0	145
-19		7069	23.80	14.9	4.3	13.0	13.0	3.2	2.5	128
-20		8168	28.66	14.3	0.0	27.3	27.3	5.2	3.0	122
-21		7281	24.27	15.0	0.0	10.0	15.0	7.6	6.0	111
-22		11031	35.47	15.6	0.0	0.0	0.0	6.2	2.0	117
-23		6958	21.74	16.0	0.0	0.0	0.0	7.2	5.5	111
-24		5427	19.04	14.3	0.0	0.0	9.5	7.4	4.5	117

TEST 692. BOLTING EVALUATION/SELECTION OF LINES WITHIN POPN-865, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.
1865-25	0865	10176	35.58	14.3	0.0	4.8	9.5	7.4	4.5	117
-26		8392	27.79	15.1	0.0	0.0	0.0	7.2	2.5	100
-27		10652	33.60	15.9	0.0	0.0	0.0	7.6	3.5	111
-28		8599	27.83	15.4	0.0	5.0	5.0	5.0	2.5	111
-29		7108	32.31	11.0	0.0	0.0	0.0	5.4	3.5	83
-30		7194	28.66	12.5	0.0	11.1	11.1	6.2	3.0	100
-31		8565	28.94	14.8	0.0	0.0	4.3	4.6	2.0	128
-32		9199	31.50	14.6	0.0	12.5	16.7	4.0	3.0	133
-33		11623	39.67	14.6	0.0	0.0	0.0	2.4	3.0	111
-34		9295	33.08	14.1	0.0	0.0	0.0	5.2	2.0	133
-35		11154	37.56	14.9	0.0	0.0	0.0	2.8	6.5	111
-36		4645	22.87	10.2	0.0	0.0	0.0	6.0	3.0	133
-37		9128	35.94	12.7	0.0	0.0	0.0	4.8	2.5	117
-38		11962	44.80	13.4	0.0	0.0	0.0	4.2	4.0	156
-39		9820	35.58	13.8	0.0	0.0	4.5	6.2	5.5	122
-40		10239	36.57	14.0	0.0	22.2	27.8	3.6	3.5	100
-41		7742	24.27	16.0	0.0	0.0	0.0	0.4	3.5	133
-42		3981	12.92	15.4	0.0	6.7	6.7	3.4	2.0	83
-43		8549	29.08	14.7	0.0	0.0	0.0	2.2	5.0	78
-44		6502	21.25	15.3	0.0	0.0	0.0	1.6	4.0	117
-45		5960	20.07	14.9	0.0	0.0	0.0	2.8	4.0	100
-46		9709	33.14	14.6	0.0	0.0	0.0	3.8	4.5	117
-47		5822	18.90	15.4	0.0	0.0	0.0	3.8	2.0	33
-48		9409	33.60	14.0	0.0	4.5	4.5	4.4	6.0	122

TEST 692. BOLTING EVALUATION/SELECTION OF LINES WITHIN POPN-865, SALINAS, CA., 1991-92

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Rust Score Mean	Beets/ 100' No.
1865-49	0865	10854	35.47	15.3	0.0	0.0	0.0	6.0	4.0	89
-50		8905	33.60	13.3	0.0	0.0	15.4	7.4	6.5	72
-51		6445	23.10	14.0	0.0	0.0	0.0	5.8	3.0	111
-52		8242	29.65	13.9	0.0	0.0	0.0	4.8	5.5	83
-53		5511	19.20	14.4	0.0	0.0	0.0	5.0	1.5	72
-54		5292	19.60	13.5	0.0	0.0	0.0	7.0	7.0	28
-55		10127	34.10	14.9	0.0	5.3	5.3	7.2	5.5	106
-56		7634	26.88	14.2	0.0	0.0	0.0	5.2	7.0	106
Checks										
87-309	Inc. C309	8101	30.80	13.1	0.0	0.0	0.0	4.0	1.5	117
87-309	Inc. C309	8902	30.80	14.4	0.0	0.0	0.0	6.0	2.5	150
87-309	Inc. C309	11387	37.34	15.3	0.0	0.0	0.0	4.6	3.0	161
87-309	Inc. C309	7475	26.14	14.3	0.0	4.2	4.2	6.0	2.0	133

TEST 792. BOLTING EVALUATION/SELECTION OF S_1 LINES FROM POPN-913 AND POPN-915

90 entries x 1 replication
1-row plots, 16 ft. long

Planted: November 1, 1991
Harvested: September 22, 1992

Variety	Description	Acre Yield		Sucrose	% Bolting			Powdery Mildew	Root Rot	Rust Score	Beets/ 100'
		Sugar Lbs	Beets Tons	%	6/01 %	7/07 %	8/27 %	Mean	%	Mean	No.
1913- 1	0913	11761	39.20	15.0	0.0	0.0	0.0	1.8	0.0	1.5	83
1913- 2	0913	10516	37.56	14.0	0.0	4.0	4.0	2.6	0.0	3.5	139
1913- 3	0913	14768	50.40	14.6	0.0	0.0	0.0	0.6	0.0	2.0	117
1913- 4	0913	14513	48.54	14.9	0.0	0.0	0.0	2.6	0.0	4.5	133
1913- 5	0913	11526	39.20	14.7	65.4	92.3	100.0	2.2	0.0	5.0	145
1913- 6	0913	7369	26.60	13.9	30.4	69.6	87.0	2.6	0.0	1.0	128
1913- 7	0913	10447	40.03	13.0	0.0	33.3	50.0	1.2	0.0	3.5	100
1913- 8	0913	12790	49.00	13.1	0.0	0.0	0.0	2.6	0.0	4.0	128
1913-12	0913	9179	33.14	13.9	0.0	9.1	13.6	2.8	0.0	2.5	122
1913-13	0913	14164	49.35	14.4	0.0	0.0	0.0	3.2	0.0	3.0	111
1913-14	0913	10887	33.60	16.2	0.0	0.0	0.0	2.8	0.0	1.0	145
1913-15	0913	11979	42.94	13.9	0.0	0.0	0.0	2.0	0.0	3.0	145
1913-17	0913	11037	40.14	13.8	0.0	50.0	50.0	1.8	0.0	4.0	133
1913-18	0913	12601	42.00	15.0	0.0	3.7	7.4	3.6	0.0	3.5	150
1913-20	0913	10350	35.94	14.4	0.0	0.0	0.0	2.4	0.0	2.5	111
1913-21	0913	9506	31.27	15.2	0.0	12.0	12.0	0.0	0.0	5.0	139
1913-22	0913	9207	33.60	13.7	0.0	6.7	20.0	3.6	0.0	3.5	83
1913-23	RZM 0913	12928	46.67	13.9	0.0	0.0	0.0	4.8	0.0	5.5	122
1913-24	RZM 0913	16204	52.27	15.5	14.8	18.5	18.5	2.2	0.0	4.5	150
1913-25	RZM 0913	8584	35.47	12.1	0.0	0.0	0.0	4.0	0.0	2.0	139
1913-26	RZM 0913	9147	32.67	14.0	17.2	31.0	51.7	6.2	0.0	3.5	161
1913-27	RZM 0913	11636	42.94	13.5	0.0	0.0	0.0	7.6	0.0	3.0	133
1913-28	RZM 0913	14358	49.00	14.6	0.0	0.0	0.0	5.2	0.0	3.5	128
1913-29	RZM 0913	14662	47.60	15.4	0.0	0.0	0.0	5.2	0.0	2.0	122
1913-30	RZM 0913	12597	52.27	12.1	0.0	0.0	0.0	4.0	5.0	2.0	111

TEST 792. BOLTING EVALUATION/SELECTION OF S_1 LINES FROM POPN-913 AND POPN-915

(cont.)

Variety	Description	Acre Yield		Sucrose	% Bolting			Powdery Mildew	Root Rot	Rust Score	Beets/ 100′
		Sugar	Beets		6/01	7/07	8/27				
		Lbs	Tons	%	%	%	%	Mean	%	Mean	No.
1913-31	RZM 0913	11878	39.20	15.1	0.0	0.0	0.0	3.4	0.0	3.0	139
1913-32	RZM 0913	13281	47.60	13.9	0.0	0.0	0.0	3.4	0.0	2.0	139
1913-33	RZM 0913	8391	28.94	14.5	0.0	0.0	0.0	3.2	0.0	6.0	117
1913-34	RZM 0913	12676	45.27	14.0	0.0	0.0	0.0	2.6	0.0	3.5	133
1913-35	RZM 0913	10754	38.27	14.0	0.0	0.0	0.0	4.4	0.0	2.0	111
1913-36	RZM 0913	9894	37.34	13.3	0.0	0.0	0.0	0.4	0.0	1.0	111
1913-38	RZM 0913	9283	42.00	11.1	0.0	0.0	0.0	0.8	0.0	1.5	133
1913-45	0913	10842	41.07	13.2	0.0	0.0	13.6	0.8	0.0	1.5	122
1913-46	0913	8737	37.34	11.7	0.0	0.0	0.0	0.4	36.4	1.5	122
1913-47	0913	13105	48.54	13.5	0.0	0.0	0.0	2.2	0.0	3.5	133
1913-48	0913	13684	50.87	13.4	0.0	0.0	0.0	1.0	0.0	3.5	122
1913-49	0913	8102	32.67	12.4	0.0	0.0	0.0	5.6	0.0	4.5	128
1913-50	0913	13567	53.20	12.8	0.0	0.0	0.0	1.0	0.0	1.0	133
1913-51	0913	13218	45.74	14.4	0.0	0.0	0.0	1.0	0.0	3.0	133
1913-52	0913	8261	28.00	14.8	0.0	0.0	0.0	1.2	0.0	3.0	122
1913-53	0913	8888	32.20	13.8	0.0	0.0	0.0	1.6	0.0	3.0	111
1913-54	0913	8632	31.74	13.6	0.0	0.0	0.0	1.4	0.0	4.0	133
1913-55	0913	11380	44.80	12.7	0.0	0.0	0.0	0.4	0.0	4.5	106
1913-56	0913	11458	41.07	13.9	0.0	0.0	12.0	0.6	0.0	1.5	139
1913-57	0913	7608	30.80	12.4	0.0	0.0	0.0	0.6	0.0	2.5	117
1913-58	0913	10872	48.54	11.2	0.0	4.3	4.3	2.6	0.0	2.0	128
1913-59	0913	10193	39.20	13.0	0.0	0.0	0.0	3.4	0.0	3.0	100
1913-60	0913	10863	42.94	12.6	0.0	0.0	0.0	4.6	0.0	3.5	139
1913-61	0913	12276	44.80	13.7	0.0	0.0	0.0	2.8	0.0	2.5	150
1913-62	0913	11318	40.14	14.1	0.0	0.0	0.0	3.4	0.0	4.5	139

TEST 792. BOLTING EVALUATION/SELECTION OF S_1 LINES FROM POPN-913 AND POPN-915

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Root Rot %	Rust Score Mean	Beets/ 100' No.
1913-63	0913	7033	25.67	13.7	0.0	0.0	0.0	4.0	0.0	3.0	128
1913-64	0913	9115	32.67	13.9	0.0	0.0	0.0	3.0	0.0	4.5	111
1913-65	0913	8793	38.74	11.4	0.0	0.0	0.0	1.2	0.0	3.0	100
1913-66	0913	10155	37.34	13.6	12.5	25.0	25.0	2.6	0.0	1.0	133
1913-67	0913	11720	40.14	14.6	0.0	8.3	8.3	1.4	0.0	4.5	133
1913-68	0913	12323	42.94	14.4	0.0	0.0	0.0	1.8	0.0	5.0	117
1913-69	0913	10267	37.34	13.8	0.0	8.3	8.3	5.0	0.0	2.5	133
1913-70	0913	12055	38.27	15.8	0.0	0.0	0.0	2.0	0.0	4.0	139
1913-71	0913	18758	59.74	15.7	0.0	0.0	0.0	1.6	0.0	1.0	145
1913-72	0913	11130	41.07	13.6	0.0	0.0	0.0	2.8	0.0	3.0	139
1913-73	0913	11023	45.74	12.1	0.0	0.0	0.0	0.4	0.0	1.0	106
1913-74	0913	14292	52.74	13.6	0.0	0.0	0.0	0.8	0.0	2.0	128
1913-75	0913	14743	60.67	12.1	0.0	0.0	0.0	0.8	0.0	2.0	117
1913-76	0913	9095	39.20	11.6	0.0	4.0	4.0	1.2	0.0	4.5	139
1913-77	0913	12925	56.94	11.4	0.0	19.0	19.0	1.6	0.0	2.5	117
1913-78	0913	9359	34.54	13.6	0.0	0.0	25.0	2.6	0.0	6.0	111
1913-79	0913	11874	46.20	12.9	0.0	0.0	5.9	2.6	0.0	1.5	95
1913-80	0913	6030	31.74	9.5	0.0	0.0	0.0	1.2	0.0	3.0	128
1915- 1	0915	12635	44.80	14.1	0.0	4.0	8.0	0.8	0.0	4.5	139
1915- 2	0915	12959	48.54	13.4	4.0	4.0	4.0	1.0	0.0	2.0	139
1915- 3	0915	10467	39.20	13.4	0.0	0.0	0.0	1.4	0.0	2.0	150
1915- 4	0915	11823	49.47	11.9	0.0	0.0	0.0	2.2	0.0	3.5	139
1915- 5	0915	9180	32.67	14.1	0.0	0.0	0.0	1.4	0.0	3.5	133

TEST 792. BOLTING EVALUATION/SELECTION OF S_1 LINES FROM POPN-913 AND POPN-915

(cont.)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	% Bolting 6/01 %	% Bolting 7/07 %	% Bolting 8/27 %	Powdery Mildew Mean	Root Rot %	Rust Score Mean	Beets/ 100' No.
1915- 6	0915	10627	42.00	12.6	0.0	0.0	0.0	0.4	0.0	2.5	133
1915- 7	0915	10777	42.94	12.5	0.0	0.0	0.0	1.0	0.0	2.5	133
1915- 8	0915	9623	36.87	13.0	0.0	0.0	0.0	0.4	0.0	2.5	106
1915- 9	0915	11625	43.87	13.3	0.0	0.0	0.0	2.6	0.0	2.5	122
1915-10	0915	11066	36.40	15.2	0.0	0.0	0.0	2.4	0.0	4.0	133
1915-11	0915	10955	45.27	12.1	0.0	0.0	0.0	0.8	0.0	2.0	133
1915-12	0915	12997	55.07	11.8	0.0	0.0	0.0	2.4	0.0	3.0	117
1915-13	0915	10996	47.60	11.6	0.0	0.0	4.5	3.4	0.0	4.0	122
1915-14	0915	13186	47.60	13.9	0.0	0.0	0.0	1.0	0.0	5.0	133
1915-15	0915	12988	51.34	12.6	0.0	0.0	0.0	0.6	0.0	2.0	117
1915-16	0915	15065	56.00	13.5	0.0	0.0	0.0	1.6	0.0	1.0	145
1915-17	0915	9528	41.07	11.6	18.2	40.9	40.9	0.6	0.0	2.5	122
1915-18	0915	11873	44.80	13.3	0.0	0.0	0.0	3.4	0.0	2.5	111
1915-19	0915	10781	46.67	11.6	0.0	0.0	0.0	2.4	0.0	2.5	139
1915-20	0915	10790	37.34	14.5	0.0	0.0	0.0	1.2	0.0	3.0	100
1915-21	0915	9913	33.60	14.8	0.0	0.0	0.0	2.6	0.0	4.0	122
1915-22	0915	11480	45.74	12.5	0.0	0.0	0.0	0.8	0.0	2.5	139

TEST 2292. ERR-PM EVALUATION AND OBSERVATION OF LINES AND POPULATIONS, SALINAS, CA., 1992

160 entries x 3 reps, RCB
1-row plots, 18 ft. long

Planted: April 8, 1992
E.c.b. Inoc.: July 9, 1992
Scored: Rows 15-22 Oct. 13, 1992
Rows 23-30 Oct. 19, 1992

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
Block 1					
MM, O.P. lines					
US H11	113401	26	4.7	75.8	3.2
E840	Inc. E440, E640	23	94.2	4.3	3.5
768	Inc. 868 (US75)	22	38.2	50.0	2.4
U86-37	C37, 86443	27	9.1	80.6	2.4
R979	Inc. R879	25	4.7	88.3	2.0
R079	RZM R979	27	5.1	90.0	2.2
1204-#P(C)	R079 x C37	21	1.8	95.2	2.6
R028	RZM 9221	24	8.9	80.8	2.9
R128	RZM 0271-#	27	18.5	66.5	2.3
1202-#P(C)	RZM 0271 x C37	24	13.5	77.0	2.9
R030	RZM 9225	24	5.3	90.6	0.9
R130	RZM R030	23	14.6	75.7	1.7
1201-#P(C)	RZM R004 x C37	20	1.9	93.3	1.6
R121	BYR R921, R924, R925	25	14.3	79.7	1.7
1211-#(C)	C37 x EDW- 7 (WB97)	25	12.4	81.8	1.7
1213-#(C)	C37 x EDW-11 (WB97)	23	7.0	86.1	1.6
Block 2					
1214-#(C)	C37 x EDW-12 (WB242)	22	4.1	88.0	1.9
1215-#(C)	C37 x EDW-13 (WB97)	22	7.5	79.9	1.0
1216-#(C)	C37 x EDW-14 (WB242)	20	3.9	85.1	1.1
E840	Inc. E440, E640	25	89.6	9.2	2.0
Y954	Inc. Y854	24	0.8	95.8	0.5
R080 (Sp)	Inc. R980	22	15.5	80.5	1.0
R080 (Iso)	RZM R980	24	17.3	73.1	1.1
Y054 (Iso)	BYR-ER-PMR Y854	25	4.8	91.0	1.0
Y054-38	Inc. Y854-38	25	4.4	86.1	0.5
R722	Inc. F &F (SB x B.m.)	24	28.0	59.4	1.1
R022R2	RZM R922R2	24	28.1	60.1	1.7
R122R3	RZM R022 R2	24	57.1	30.4	1.5
R022Y	Inc. R922Y	27	21.9	69.4	1.6
R122Y2	BYR R922Y,S; R918	25	31.8	61.7	1.5
R970	RZM R971-R879, 8244	22	19.3	74.1	1.9
R070	Inc. R971-R980	23	21.1	73.2	2.1

TEST 2292. ERR-PM EVALUATION AND OBSERVATION OF LINES AND POPULATIONS, SALINAS, CA., 1992

(cont.)

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
Block 3					
U86-46/2	C46/2, 86342	22	9.5	74.2	1.1
Y846 (Sp)	Inc. Y746	22	5.7	80.5	0.8
R978C2	RZM R878	21	9.0	81.9	1.1
R078	RZM R978C2	20	8.1	80.1	1.3
F86-31/6	86263, Inc. C31/6	22	13.5	75.8	0.9
Y931	Inc. Y731	22	14.5	73.6	0.7
R971	RZM R871	15	40.4	47.5	2.5
R076	RZM R976	19	13.4	73.8	1.8
R176-43-#(C)	Y931-43 x R076	21	7.8	78.8	1.5
R176-89-#(C)	Y931-89 x R076	16	18.4	78.0	1.2
Y931-43	Inc. Y731-43	16	4.7	91.8	1.4
Y131-43	BYR Y931-43	22	1.6	94.2	0.7
Y931-89	Inc. Y731-89	25	6.9	88.3	1.3
Y131-89	BYR Y931-89	23	15.1	78.4	1.6
US H11	113401	26	5.6	87.3	2.9
E840	Inc. E440, E640	19	90.8	7.4	2.8
Block 4					
F86-91	Inc. C91, 86019	24	2.1	91.8	0.7
Y941	YR-ER-PMR Y741	23	6.0	86.4	0.5
Y141	BYR Y941	23	10.0	87.3	0.4
Y948	YR-ER-PMR Y748	22	4.4	88.4	0.8
Y148	BYR Y948	24	1.5	95.9	0.7
Y049	BYR-ER-PMR Y849	24	4.1	94.0	0.5
Y956	YR-ER-PMR Y756, Y656	25	11.0	75.9	0.7
Y156	BYR Y956	26	6.9	89.1	0.9
Y057	BYR-ER-PMR Y857	27	1.4	90.6	1.1
Y039	Inc. Y939	23	11.6	85.0	0.7
Y139	BYR Y939	25	10./0	86.7	0.5
E840	Inc. E440, E640	22	98.0	1.3	2.1
US H11	113401	28	4.2	83.2	3.1
R839-6	RZM R739-6	20	3.4	95.4	0.3
R039C5	Inc. R939C5	25	17.0	75.1	0.5
R039C6	RZM R939C5	22	19.3	71.4	0.5
Block 5					
R139C7	RZM R039C6	24	17.8	76.4	0.3
Y047	Inc. 947	21	10.5	85.6	0.9
Y147	BYR Y947	24	3.8	93.1	1.0
R047C5	Inc. R947C5	21	4.8	90.5	1.5
R047C6	RZM R947C5	25	10.2	82.8	1.5
R147C7	RZM R047C6	23	9.5	84.0	1.7
E840	Inc. E440, E640	22	89.1	9.3	3.2
US H11	113401	27	7.4	80.5	3.1

TEST 2292. ERR-PM EVALUATION AND OBSERVATION OF LINES AND POPULATIONS, SALINAS, CA., 1992

(cont.)

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
Block 5 (cont.)					
R104	RZM R004	26	10.8	79.7	1.6
R105	RZM R005	21	18.5	73.1	1.4
R106	RZM R006	20	47.7	47.8	1.4
R107	RZM R007	23	15.1	74.7	2.1
R108	RZM R008	23	27.9	64.1	2.1
R119	RZM 9010081	22	28.1	64.1	1.3
R020 (Sp)	Inc. R920	24	31.9	65.0	1.2
R120	RZM R020	21	40.8	51.5	1.0
Block 6					
E840	Inc. E440, E640	20	84.8	13.1	3.1
US H11	113401	26	8.6	82.3	3.3
9101	Inc. 8101 (C11T)	19	8.0	89.1	0.9
9102	Inc. 8102 (C12T)	19	10.0	82.5	1.0
Z010	Inc. P1,...P7	16	22.2	68.6	1.7
Z010H12	9912aa x Polish#(C)	23	10.0	83.3	1.7
Z120	RZM Z010H12	25	10.3	84.3	2.0
Z011	Inc. Polish #1	19	15.8	80.3	2.7
Z012	Inc. Polish-2	17	13.8	77.7	2.3
Z012H12	9912aa x Polish-2	22	9.2	80.2	2.5
Z122	RZM Z012H12	22	11.9	72.3	2.1
Z013	Inc. Polish #3	19	15.1	74.9	1.9
Z014	Inc. Polish-4	18	24.3	69.2	2.4
Z014H12	9912aa x Polish-4	23	9.4	81.4	1.5
Z124	RZM Z014H12	24	17.5	72.8	1.9
Z017	Inc. Polish #7	16	20.1	64.2	1.6
Block 7					
U86-37	C37 84443	23	16.8	72.3	2.1
MM, S^f, A:aa Lines and Populations					
9905	YR-ER-PMR 7905 (A,aa)	22	2.0	93.8	1.0
1905	BYR 9905 (A,aa)	20	6.9	88.0	0.5
0914	RZM R939/4 H44	21	6.5	90.6	0.5
1914	RZM 0914	22	12.4	82.1	0.9
5747	4747aa x A	20	0.7	97.2	1.5
9910 (Sp)	8910aa x A(C)	22	4.0	91.0	1.3
9910 H47	5747aa x 8910	23	2.1	92.3	1.7
0910	RZM 9910H47 (A,aa)	18	7.3	82.3	1.7
1210-#(C)	5747aa x 0910	28	2.2	92.3	1.7

TEST 2292. ERR-PM EVALUATION AND OBSERVATION OF LINES AND POPULATIONS, SALINAS, CA., 1992

(cont.)

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
Blockf7 (cont.)					
MM, S , A:aa Lines and Populations (cont.)					
R029	RZM 9223	23	6.0	89.8	1.5
R129	RZM 0281-#	23	11.5	78.5	1.7
1207-#(C)	RZM 0281aa x 5747	23	8.0	80.7	1.9
R031	RZM 9226	23	8.2	85.0	1.9
R131	RZM R031	21	10.5	84.4	2.9
1205-#(C)	5747aa x RZM R004	20	4.3	89.3	2.1
Block 8					
1217-#(C)	5747aa x EDW-11 (WB97)	24	10.0	83.2	1.9
1218-#(C)	5747aa x EDW-12 (WB242)	25	12.7	75.2	1.5
E840	Inc. E440, E640	23	86.7	11.9	3.2
US H11	113401	24	6.9	85.6	2.9
8909 (Sp)	7909,7239aa x A	23	2.3	93.9	1.2
9912	RZM 8908,9,10,11aa x A	21	4.8	86.1	1.5
9911 (Sp)	8911aa x A	23	6.4	87.1	1.3
0911 (Sp)	9911 (Iso)aa x A	25	9.4	76.8	2.4
0911 (Iso)	RZM 9911 (A,aa)	23	11.3	85.0	1.3
0913 (Iso)	RZM 9911H49 (A,aa)	24	6.6	81.8	1.2
0913 (Sp)	9911H49aa x A	22	5.9	85.3	1.4
1913-#(C)	(RZM 9911H49aa x A)	22	9.0	82.1	1.1
1913	RZM 0913 (Sp) (A,aa)	24	14.4	80.1	1.5
0915	9903aa x 9911H49, 9911	25	5.3	84.7	1.3
1915	RZM 0915 (A,aa)	20	0.0	100.0	1.5
1915-#(C)	(9903aa x 9911,9911H49)	22	7.8	88.1	1.6
Block 9 f					
Monogerm, S , A:aa Populations					
0790	8790-S (C)aa x A	24	19.7	60.3	1.3
1890	RZM 0790H124 (A,aa)	26	22.4	66.2	2.3
1890HO	0790H104CMS x RZM 0790H124	20	30.9	49.1	2.1
8776 (Iso)	NB 6776 (A,aa)	20	6.2	81.4	1.8
1876	RZM 0876	20	21.1	64.1	1.7
0787	BYR-ER-PMR 8787	25	5.8	85.0	1.3
0887	RZM 9887H86	23	30.6	54.9	2.5
1887	RZM 0887	24	35.6	53.7	2.6
F82-546H3	F66-562HO x F78-546	26	6.8	77.0	2.7
0859	RZM 9859H6	23	16.8	66.9	2.6

TEST 2292. ERR-PM EVALUATION AND OBSERVATION OF LINES AND POPULATIONS, SALINAS, CA., 1992

(cont.)

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	% Resistant	P.M.[2] Avg.
Block 9 (cont.)					
Monogerm, S , A:aa Populations (cont.)					
1859	NB9859m (A,aa)	21	30.8	59.7	2.9
1859R	RZM 0859 (A,aa)	23	30.5	55.9	3.1
F82-546	Inc. C546	23	9.1	76.0	2.2
8767 (Iso)	NB 6767 (A,aa)	28	16.5	69.2	1.4
0864	9864aa x A	22	25.7	69.4	2.2
1864	RZM 0864 (Sp) (A,aa)	20	38.4	48.6	2.3
Block 10					
0867	RZM 9867H67Iso 13	23	17.5	72.0	2.2
1867	NB 9867m (A,aa)Iso 45	26	20.1	66.3	2.3
1867R	RZM 0867 (A,aa)Iso 52	24	15.2	67.5	2.5
E840	Inc. E440, E640	22	87.9	11.8	2.7
0755	BYR-ER-PMR 8755	26	8.2	79.3	1.4
0866	RZM 9866H80	22	26.8	63.8	1.5
1866	RZM 0866 (A,aa)	22	32.2	57.9	1.9
9855	RZM 8855	23	26.9	57.2	1.7
0865	RZM 9865	23	29.1	62.0	2.3
1865	RZM 0865 (A,aa)	24	13.3	74.4	2.5
1865-#(C)	0865-#	20	42.1	51.9	2.1
87-309	Inc. 86-309, 87672	26	11.5	70.1	2.6
87-309CMS	309CMS x 309, 87670	27	15.1	71.2	2.7
F82-546H3	562HO x 546, 82460	26	7.7	84.5	3.1
0722	Inc. T-O 9722-#	23	9.3	84.9	1.1
U86-37	Inc. C37, 86443	26	11.3	81.2	2.9
Mean		22.8	17.4	74.3	1.7
LSD (.05)		5.6			1.0
C.V. (%)		15.4	42.2	13.8	36.4
F value		1.5**	21.5**	10.7**	4.4**

1
Erwinia root rot: DI = avg. % rot per root at harvest; % resistant = 2percent of roots scored 0 and 1% rot.

Powdery mildew not controlled. Score on scale of 0 to 9 where 9 = 90-100% of mature leaf area covered by visable mildew. PM scored 7/16, 7/23, 7/31, 8/6 and 8/19/92.

TEST 2492. ERR-PM EVALUATION AND OBSERVATION OF SELECTED PROGENY LINES, SALINAS, CA., 1992

80 entries x 3 reps, RCB
1-row plots, 18 ft. long

Planted: April 8, 1992
E.c.b. Inoc.: July 9, 1992
Scored: October 22, 1992

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
MM, S[f], A:aa Popns & Lines					
Block 1					
US H11	113401	21	10.9	64.1	3.2
E840	Inc. E440, E640	22	91.9	5.9	3.6
U86-37	C37, 86443	25	8.9	79.7	2.8
8909(Sp)	7909, 7239aa x A	25	9.5	81.9	1.9
0906- 4	Inc. 8906A- 4	22	23.4	64.1	2.3
0906- 7	Inc. 8906A- 7	22	16.9	68.0	3.0
0909- 7	Inc. 8909A- 7	25	4.5	90.8	2.0
0909-34	Inc. 8909A-34	26	0.8	97.5	0.7
Block 2					
0909-37	Inc. 8909A-37	22	2.1	93.2	0.9
0909-48	Inc. 8909A-48	24	19.7	71.5	2.3
1907-14	RZM 9907-14	16	35.1	39.2	1.9
1908- 7	RZM 9908- 7	19	34.7	50.3	2.2
1909-13	RZM 9909-13	22	30.6	55.1	2.9
1911- 4	Inc. 9911- 4 (A,aa)	19	3.4	86.6	1.1
1911-12	Inc. 9911-12 (A,aa)	17	13.7	66.6	1.6
E840	Inc. E440, E640	20	92.8	6.7	3.1
Block 3					
0911(Sp)	9911 (Iso)aa x A	23	13.5	75.1	2.7
1911-14	Inc. 9911-14 (A,aa)	25	9.2	82.7	1.8
1911-50	Inc. 9911-50 (A,aa)	26	3.6	90.3	1.3
1912- 3	Inc. 1912- 3 (A,aa)	27	8.1	79.9	2.2
1912-11	Inc. 9912-11 (A,aa)	23	12.5	79.9	2.7
9912	RZM 8908,09,10,11aa x A	23	6.1	85.7	2.7
US H11	113401	23	6.9	76.4	3.1
E840	Inc. E440, E640	20	93.0	5.0	3.1
Block 4					
1913- 5	Inc. 9911H49- 5 (A,aa)	24	5.7	88.8	1.0
1913-18	Inc. 9911H49-18 (A,aa)	23	2.6	95.6	1.4
1913-22	Inc. 9911H49-22 (A,aa)	24	2.1	93.0	1.4
1913-25	Inc. 9911H49-25 (A,aa)	22	4.3	90.6	1.3

TEST 2492. ERR-PM EVALUATION AND OBSERVATION OF SELECTED PROGENY LINES, SALINAS, CA., 1992

(cont.)

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
Block 4 (cont.)					
0913(Sp)	9911H49aa x A	25	4.3	87.4	1.0
1913	RZM 0913 (Iso) (A,aa)	26	11.3	78.2	1.9
0911-1	9911-1aa x A (half-sib)	25	6.2	89.1	0.9
0911-4(B)	9911-4(B)aa x A (half-sib)	24	4.1	81.9	1.1
Block 5					
0911-24	9911-24aa x A (half-sib)	21	40.3	44.4	2.1
0913-6	9911H49-6aa x A (half-sib)	24	1.7	91.0	1.5
0913-9	9911H49-9aa x A (half-sib)	20	2.0	93.2	1.3
0915-1	9903-1aa x9911H49(half-sib)	21	7.9	77.7	1.3
0915-4	9903-4aa x9911H49(half-sib)	24	4.9	89.5	1.3
0915-6	9903-6aa x9911H49(half-sib)	22	3.0	78.9	1.3
0915-7	9903-7aa x9911H49(half-sib)	23	6.4	86.9	1.2
0915-16	9903-16aax9911H49(half-sib)	26	15.4	67.3	0.9
Block 6					
0915-22	9903-22aax9911H49(half-sib)	24	1.4	97.5	1.7
0915-23	9903-23aax9911H49(half-sib)	21	1.3	93.9	0.9
0915-24	9903-24aax9911H49(half-sib)	28	0.1	98.7	1.3
0915-27	9903-27aax9911H49(half-sib)	22	13.0	77.8	1.1
0915-34	9903-34aax9911H49(half-sib)	21	2.3	90.6	1.5
0915-46	9903-46aax9911H49(half-sib)	22	2.7	91.0	1.7
1915	RZM 0915 (A,aa)	21	8.8	83.3	1.8
E840	Inc. E440, E640	21	90.7	8.5	2.9
Block 7 Progenies from R80					
R080- 1	Half-sib Inc. R980	20	12.2	78.8	1.5
R080-13	Half-sib Inc. R980	21	11.5	81.6	0.7
R080-28	Half-sib Inc. R980	19	4.0	91.6	1.4
R080-35	Half-sib Inc. R980	23	36.0	50.2	0.9
E840	Inc. E440, E640	22	87.3	11.0	2.8
R080 Iso	RZM R980	22	13.9	70.2	1.6
R080-45	Half-sib Inc. R980	25	16.6	72.1	1.1
R080-56	Half-sib Inc. R980	18	4.1	83.3	0.5
Block 8					
R080-79	Half-sib Inc. R980	22	12.5	81.3	1.1
R080-80	Half-sib Inc. R980	21	4.0	88.9	1.0
Y054 Iso	BYV-ER-PMR Y854	26	6.2	86.4	0.9
US H11	113401	23	8.6	72.5	2.6

TEST 2492. ERR-PM EVALUATION AND OBSERVATION OF SELECTED PROGENY LINES, SALINAS, CA., 1992

(cont.)

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
Progenies from popn-864					
0864- 1	9864- 1aa x A (half-sib)	27	36.3	45.1	1.9
0864- 5	9864- 5aa x A (half-sib)	25	50.7	31.8	2.7
0864- 8	9864- 8aa x A (half-sib)	20	17.0	70.0	2.3
0864-14	9864-14aa x A (half-sib)	19	27.6	53.0	2.2
Block 9					
US H11	113401	23	7.5	76.8	2.4
1864	RZM 0864 (Sp)	24	43.7	41.3	2.4
E840	Inc. E440, E640	22	97.8	2.2	2.9
0864-19	9864-19aa x A (half-sib)	17	43.5	39.5	2.3
0864-25	9864-25aa x A (half-sib)	18	52.1	34.4	2.1
0864-28	9864-28aa x A (half-sib)	16	33.4	42.5	2.3
0864-34	9864-34aa x A (half-sib)	20	39.1	41.2	2.1
0864-40	9864-40aa x A (half-sib)	14	12.3	53.8	2.3
Block 10					
Nematode resistant lines					
N801(A)	Inc. B883	17	37.4	51.4	2.5
N103	NR 0204-1,2,3P	13	43.5	43.5	4.3
N152	NR-RZM 0204-2 (C)	19	9.9	79.1	3.5
N144-1-#(C)	NR 0204-1-#(C)	19	18.9	68.5	2.9
N144-2-#(C)	NR 0204-2-#(C)	21	31.7	56.2	2.7
N144-3-#(C)	NR 0204-3-#(C)	23	30.5	51.7	2.9
1227-#(C)	0241-40-#	19	18.0	68.6	2.8
1230-#(C)	0244-10-#	20	18.0	73.6	1.0
Mean		21.9	21.0	68.3	1.9
LSD (.05)		6.1	12.7	17.4	0.7
C.V. (%)		17.4	37.4	15.8	21.8
F value		1.9**	29.0**	15.7**	11.3**

[1] Erwinia root rot: DI = avg. % rot per root at harvest; % resistant = percent of roots scored 0 and 1% rot.

[2] Powdery mildew not controlled. Scored on scale of 0 to 9 where 9 = 90-100% of mature leaf area covered by visable mildew. PM scored 7/06, 7/23, 7/31, 8/06 and 8/19/92.

TEST 2192. ERR-PM EVALUATION AND OBSERVATION OF HYBRIDS AND S^f LINES, SALINAS, CA., 1992

120 entries x 2 reps, RCB
1-row plots, 18 ft. long

Planted: April 8, 1992
E.c.b. Inoc.: July 9, 1992
Scored: Rows 1-4 Sep. 25, 1992
Rows 5-8 Oct. 07, 1992

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M. Avg.[2]
TEST 2192-1 HYBRIDS. 64 entries, 8 blocks.					
Block 1					
US H11	113401	25	3.9	83.9	4.5
E840	Inc. E440, E640	20	93.7	5.6	3.9
E840H72	83-718HO x E440	21	63.4	23.9	4.0
E840H8	F82-546H3 x E440	22	37.8	38.6	3.9
6625	Beta 6625 (0011-1)	19	16.8	72.5	2.7
WS-PM9	PMR Hilleshog	20	18.6	61.2	0.6
HH84	Holly (4/1/92)	26	10.3	85.6	2.7
HH66	Holly (663302)	23	9.9	75.9	2.9
Block 2					
HH37	Holly (373409)	30	13.0	76.1	2.4
SSNB3	Spreckels (1/22/89)	26	13.0	74.5	2.3
4757	Betaseed	26	1.9	98.2	2.0
Y039H20	87-309H3 x Y939	22	17.5	73.9	2.3
Y047H20	87-309H3 x Y947	24	3.6	82.9	2.8
R070H20	87-309H3 x R971-R980	20	19.5	61.4	3.4
Y054H20	87-309H3xBYR-ER-PMR Y854	25	3.4	92.2	2.5
R080H20	87-309H3 x R980	20	14.1	75.0	3.1
Block 3					
Y054-38H20	87-309H3 x Y854-38	25	7.9	80.0	2.1
Z010H20	87-309H3 x P#(C)	22	12.5	77.7	3.4
R080H8	F82-546H3 x R980	19	5.2	83.2	2.8
R080H18	88-790-68H26 x R980	18	16.1	80.6	2.7
R080H23	87-309H37 x R980	24	11.2	83.3	3.1
R080H26	87-309CMS x R980	17	11.6	74.0	3.1
R080H37	9807HO x R980	20	15.4	71.7	2.6
R080H39	89-762-17CMS x R980	21	17.3	67.0	2.7
Block 4					
E840	Inc. E440, E640	18	89.8	5.9	3.5
E840H72	83-718HO x E440	23	73.0	13.0	4.1
E840H8	F82-546H3 x E440	24	28.5	48.4	3.7
US H11	113401	19	1.2	89.9	2.9
R080H54	9767-46HO x R980	20	4.1	87.1	2.1
R080H70	9766-62HO x R980	18	5.1	88.8	2.8
R080H3	F82-562HO x R980	22	10.0	73.3	2.9
R080H90	8790Laa x R980	24	18.9	64.0	2.3

TEST 2192. ERR-PM EVALUATION AND OBSERVATION OF HYBRIDS AND S^f LINES, SALINAS, CA., 1992

(cont.)

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M. Avg.[2]
TEST 2192-1 HYBRIDS. 64 entries, 8 blocks (cont.)					
Block 5					
R080H89	88-790-68CMS x R980	21	28.8	51.9	2.5
R080H29	8790A- 6aa x R980	26	6.2	86.3	2.5
R080H30	8790A-15aa x R980	22	14.6	74.5	1.9
R080H33	8790A-54aa x R980	23	7.0	87.2	2.6
R080H34	8790A-55aa x R980	21	14.4	68.3	3.0
Y931DH18	88-790-68H26 x Y731/D	18	21.7	60.8	2.3
Y931DH20	87-309H3 x Y731/D	23	17.3	73.1	2.8
Y931H89	88-790-68CMS x Y731	19	21.3	63.8	2.2
Block 6					
0913H39	89-762-17CMS x 9911H49	22	21.6	59.8	2.4
0913H8	F82-546H3 x 9911H49	27	3.7	88.5	3.0
0913H20	87-309H3 x 9911H49	20	10.3	82.8	3.0
0909-7H20	87-309H3 x 8909A-7	19	5.9	81.1	2.7
0909-34H20	87-309H3 x 8909A-34	26	4.2	90.5	2.1
0909-37H20	87-309H3 x 8909A-37	22	6.3	86.0	2.7
1907-14H20	87-309H3 x RZM 9907-14	23	12.6	74.7	3.9
1908-7H20	87-309H3 x RZM 9908- 7	24	24.6	64.6	4.0
Block 7					
1909-13H20	87-309H3 x RZM 9909-13	25	33.3	43.6	4.0
1911- 4H20	87-309H3 x 9911- 4	21	6.3	80.5	2.3
1911-12H20	87-309H3 x 9911-12	20	8.1	82.1	2.5
1911-14H20	87-309H3 x 9911-14	24	14.7	75.7	3.7
US H11	113401	19	2.4	86.8	3.7
E840	Inc. E440, E640	20	93.5	2.3	3.6
E840H72	83-718HO x E440	24	72.9	10.3	3.7
E840H8	F82-546H3 x E440	22	25.9	48.8	3.6
Block 8					
1911-50H20	87-309H3 x 9911-50	25	5.5	84.8	2.7
1912- 3H20	87-309H3 x 9912- 3	23	2.3	89.2	3.7
1912-11H20	87-309H3 x 9912-11	24	18.1	56.3	4.1
1913- 5H20	87-309H3 x 9911H49-5	23	10.1	80.4	2.8
1913-18H20	87-309H3 x 9911H49-18	22	5.3	88.8	2.9
1913-22H20	87-309H3 x 9911H49-22	16	3.6	92.9	2.6
1913-25H20	87-309H3 x 9911H49-25	15	15.6	80.6	3.1
E840	Inc. E440, E640	20	92.6	5.3	3.7

TEST 2192. ERR-PM EVALUATION AND OBSERVATION OF HYBRIDS AND S^f LINES, SALINAS, CA., 1992

(cont.)

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M. Avg.[2]
TEST 2192-2 S^f LINES. 56 entries, 7 blocks					
Block 9					
F82-546H3	82460	26	8.2	78.5	2.0
87-309H37	87242	27	26.0	60.6	2.7
87-309H3	87671	25	10.6	73.7	3.4
88-790-68H26	88189	27	12.9	65.6	3.9
88-790-68H92	88190	19	4.4	74.6	2.7
88-790-68H37	88191	25	17.0	62.6	2.1
E840	Inc. E440, E640	22	90.8	4.8	4.4
US H11	113401	24	2.0	89.2	3.2
Block 10					
83-718	83246	26	33.1	48.2	2.5
F82-562	82196	22	16.4	54.2	2.8
F82-562HO	82195	22	15.2	56.1	3.2
F82-546	82372	20	4.0	85.0	3.2
1790- 6	8790- 6	19	14.5	76.2	1.2
1790-15	8790-15	20	27.4	45.3	0.6
1790-54	8790-54	20	17.8	64.3	0.6
1790-55	8790-55	20	25.4	61.9	1.6
Block 11					
0790	8790-S_1(C)aa x A	21	14.5	58.1	2.4
1890	RZM 0790H124 (A,aa)	22	20.3	66.2	2.8
88-790-68	88192	24	23.3	56.4	1.6
88-790-68CMS	88187	24	30.0	48.3	2.0
89-762-17	89121	21	74.3	16.6	0.8
91-762-17	10/22/91	19	37.6	50.3	0.4
91-762-17CMS	10/22/91	20	51.3	29.3	1.3
9807	T-O 8807-# (C306)	28	32.3	44.8	0.8
Block 12					
0833	Inc. T-O 9833-#	25	41.7	34.9	2.5
0767-46	Inc. T-O 9767-46-#	25	2.0	94.1	2.4
91-767-46	10/22/91	24	3.9	91.2	2.0
0796-43	Inc. 5796-43	27	8.9	69.7	2.8
0766-62	Inc. 9766-62	24	1.6	95.7	2.6
F82-546	82372	19	4.1	90.6	2.7
E840	Inc. E440, E640	22	83.1	14.0	4.0
1865	RZM 0865 (A,aa)	20	15.5	75.8	2.7

TEST 2192. ERR-PM EVALUATION AND OBSERVATION OF HYBRIDS AND S^f LINES, SALINAS, CA., 1992

(cont.)

Variety	Description	Harv. Count/ Plot	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M. Avg.[2]
TEST 2192-2 S^f LINES. 56 entries, 7 blocks (cont.)					
Block 13					
1865-#(C)	0865-#	25	23.9	68.1	2.3
87-309	87672	29	11.1	75.9	3.3
87-309CMS	87670	28	12.0	70.0	3.0
1855-24	RZM 9855-24-4	23	18.6	68.9	1.5
1855-59	RZM 9855-59-1	20	28.0	61.2	2.7
1855-21-5-#(C)	RZM 9855-21-5-#	24	8.7	79.4	2.5
1855-22-2-#(C)	RZM 9855-22-2-#	19	20.3	63.8	0.9
1855-24-#(C)	RZM 9855-24-2,3,5-#(C)	10	7.3	80.8	1.4
Block 14					
1855-56-3-#(C)	RZM 9855-56-3	20	9.6	80.0	1.6
1855-56-6-#(C)	RZM 9855-56-6	19	27.0	64.8	0.9
1855-59-2-#(C)	RZM 9855-59-2	9	15.8	78.5	0.6
1855-59-3-#(C)	RZM 9855-59-3	5	45.0	42.5	0.6
1855-59-4-#(C)	RZM 9855-59-4	12	4.6	90.9	1.9
1852-7	RZM 0852-7	18	3.1	92.9	2.2
1852-52	RZM 0852-52	13	9.2	72.1	2.4
1852-3-5-#(C)	RZM 9852-3-5-#	17	19.3	66.6	2.0
Block 15					
F82-546	82372	17	9.6	79.5	2.6
1852-46-4-#(C)	RZM 9852-46-4-#	19	8.9	75.3	2.2
1864	RZM 0864 (A,aa)	21	31.7	56.8	3.1
1867	NB 9867m (A,aa)	20	20.5	62.5	2.9
1867R	RZM 0867 (A,aa)	25	14.5	74.2	2.9
1859	NB 9859m (A,aa)	20	26.7	62.0	3.1
1859R	RZM 0859 (A,aa)	22	10.6	71.5	3.7
E840	Inc. E440, E640	20	84.5	10.7	3.8
Mean		21.2	21.2	66.3	2.6
LSD (.05)		7.6	16.8	23.4	1.1
C.V. (%)		17.9	40.0	17.8	20.8
F value		2.0**	13.8**	7.5**	5.4**

[1]Erwinia root rot: DI = avg. % rot per root at harvest; % resistant = percent of roots scored 0 and 1% rot.

[2]Powdery mildew not controlled. Score on scale of 0 to 9 where 9 = 90-100% of mature leaf area covered by visable mildew. PM scored 7/16, 7/23, 7/31, 8/7 and 8/19/92.

TEST 1592. CODED POWDERY MILDEW TEST,
SALINAS, CA., 1992

192 entries x 6 reps, RCB
1-row plots, 8 ft. long

Planted: February 25, 1992

Entry No.	Variety	Co.	Beets/ Plot No.	Powdery Mildew Score 7/20	7/27	8/05	8/12	8/25	Mean
PM- 2	H90884	Spreck	15.5	2.2	3.7	7.0	6.8	7.0	5.3
- 3	H88242	Spreck	15.7	2.0	3.5	6.2	6.3	6.8	5.0
- 4	H89759	Spreck	15.7	2.2	2.8	5.8	5.8	7.5	4.8
- 7	H90547	Spreck	16.5	2.2	3.0	5.8	6.3	6.5	4.8
- 8	H90556	Spreck	15.0	2.0	3.3	5.7	5.7	5.8	4.5
- 9	H86558	Spreck	15.8	1.2	2.8	4.2	4.8	5.5	3.7
- 12	H90277	Spreck	15.2	2.2	2.5	4.8	4.8	5.7	4.0
- 14	SS-231	Spreck	16.5	1.7	2.0	4.2	4.2	5.0	3.4
- 19	H89303	Spreck	13.8	2.3	2.5	5.3	5.8	5.5	4.3
- 20	H90543	Spreck	15.7	1.8	2.5	4.2	5.0	5.8	3.9
- 25	H90276	Spreck	16.3	2.0	2.3	4.0	5.0	5.7	3.8
- 31	SS-334R	Spreck	15.2	2.2	3.8	7.0	7.8	8.2	5.8
- 32	SS-462R	Spreck	15.8	2.3	3.7	6.7	7.0	6.7	5.3
- 37	SS-377	Spreck	15.7	2.2	3.5	5.8	6.3	7.3	5.0
- 38	H89760	Spreck	15.8	1.7	2.5	5.3	5.8	6.8	4.4
- 41	SS-334	Spreck	15.0	1.8	2.5	4.7	5.2	6.3	4.1
- 45	H88236	Spreck	15.5	1.2	2.3	4.3	4.7	3.8	3.3
- 48	H89349	Spreck	15.0	2.0	2.5	5.3	5.7	6.7	4.4
- 51	H90272	Spreck	16.5	2.0	3.0	5.0	5.5	5.7	4.2
- 52	H87354	Spreck	16.2	2.3	3.5	5.5	5.8	5.5	4.5
- 58	SS-270	Spreck	14.7	2.3	3.2	6.2	6.5	5.5	4.7
- 64	SS-261R	Spreck	15.8	1.8	2.5	4.8	5.0	4.8	3.8
- 67	H90859	Spreck	16.0	2.2	3.0	5.7	6.2	7.2	4.8
- 68	H90293	Spreck	15.7	1.2	1.8	3.3	4.0	4.5	3.0
- 69	H88199	Spreck	15.7	1.0	1.2	2.0	2.8	3.0	2.0
- 70	H87245	Spreck	16.0	1.7	2.0	4.3	5.0	6.5	3.9
- 73	SS-292R	Spreck	14.7	2.7	3.2	5.8	6.7	7.2	5.1
- 75	H88289	Spreck	16.5	2.3	3.5	5.8	6.5	7.0	5.0
- 78	H90956	Spreck	16.5	2.8	3.8	6.0	6.8	6.5	5.2
- 86	H87398	Spreck	14.8	2.2	2.8	6.0	5.8	6.5	4.7
- 87	H88335	Spreck	15.8	1.7	2.3	4.2	4.5	5.2	3.6
- 90	H91345	Spreck	16.0	2.2	3.5	6.5	5.8	6.3	4.9
-102	H89401	Spreck	15.8	1.7	2.5	5.0	5.3	5.7	4.0
-107	H90636	Spreck	16.5	2.7	2.5	5.3	5.7	6.2	4.5
-108	H90107	Spreck	15.8	2.0	2.5	5.5	5.5	6.3	4.4

TEST 1592. CODED POWDERY MILDEW TEST,
SALINAS, CA., 1992

(cont.)

Entry No.	Variety	Co.	Beets/ Plot No.	Powdery Mildew Score 7/20	7/27	8/05	8/12	8/25	Mean
PM-110	H88212	Spreck	15.8	0.8	0.8	2.7	3.5	4.0	2.4
-117	H90273	Spreck	16.0	2.3	2.8	4.7	5.2	5.0	4.0
-127	SS-502	Spreck	16.5	2.0	3.0	5.7	6.0	6.2	4.6
-128	SS-595R	Spreck	15.7	1.8	2.7	5.5	5.8	6.0	4.4
-130	H88313	Spreck	15.7	2.5	3.5	6.3	6.0	6.8	5.0
-131	H90330	Spreck	15.3	2.0	3.0	5.8	5.8	7.2	4.8
-135	SS-293R	Spreck	15.8	2.0	2.5	5.3	4.7	5.0	3.9
-150	SS-181	Spreck	15.7	2.7	3.2	5.0	5.8	5.7	4.5
-152	SS-NB3	Spreck	16.2	2.2	2.5	5.2	5.2	5.5	4.1
-154	H86246	Spreck	16.2	1.8	2.3	4.3	5.5	5.8	4.0
-155	H87356	Spreck	16.5	2.2	2.5	5.3	5.8	6.5	4.5
-159	H90373	Spreck	16.8	2.3	2.7	5.0	5.2	5.8	4.2
-160	H90509	Spreck	15.5	2.3	3.2	5.3	5.7	5.5	4.4
-162	H89299	Spreck	15.8	1.5	2.2	3.8	5.0	4.0	3.3
-163	SS-287R	Spreck	15.0	2.5	3.0	5.3	6.0	5.7	4.5
-165	H89272	Spreck	14.3	2.3	3.3	6.5	7.7	7.7	5.5
-166	H90917	Spreck	16.3	2.3	4.0	7.3	7.5	8.2	5.9
-167	SS-NB2	Spreck	16.5	2.0	3.2	7.0	6.8	7.5	5.3
-169	SS-Y1	Spreck	15.5	2.2	2.7	5.0	5.3	6.0	4.2
-172	SS-593R	Spreck	14.7	1.8	2.2	4.0	5.2	6.3	3.9
-174	H90771	Spreck	14.3	1.5	2.5	4.8	4.8	5.2	3.8
-179	H89298	Spreck	15.3	2.5	3.2	5.2	5.0	5.7	4.3
PM- 5	9BG6381	Beta	15.7	0.5	1.2	1.8	2.3	3.7	1.9
- 6	OBG6476	Beta	14.8	1.2	2.2	3.2	3.7	4.3	2.9
- 11	OBG6182	Beta	15.3	2.2	2.8	4.5	5.0	5.3	4.0
- 16	9BG6276	Beta	16.2	2.5	2.7	6.0	5.8	6.5	4.7
- 21	9BG6271	Beta	16.2	2.3	3.0	5.3	5.8	7.2	4.7
- 22	OBG6333	Beta	16.3	1.2	1.3	3.5	4.0	3.8	2.8
- 23	OBG6351	Beta	14.8	0.7	1.0	2.5	3.3	4.5	2.4
- 24	OBG6147	Beta	15.5	2.2	3.0	4.8	5.7	5.7	4.3
- 27	OBG6330	Beta	15.3	1.7	2.2	3.7	4.5	3.8	3.2
- 40	4452	Beta	15.3	0.8	1.0	2.2	2.2	4.5	2.1
- 42	4581	Beta	15.7	0.5	1.3	3.0	3.5	2.8	2.2
- 43	0BG6172	Beta	15.8	2.0	2.7	5.0	5.3	5.3	4.1
- 54	4587	Beta	14.8	1.8	2.7	4.7	5.7	5.8	4.1
- 59	9BG6269	Beta	14.8	2.8	3.5	6.5	7.5	8.0	5.7
- 60	OBG6157	Beta	15.2	0.8	0.7	3.0	3.0	4.5	2.4

TEST 1592. CODED POWDERY MILDEW TEST,
SALINAS, CA., 1992

(cont.)

Entry No.	Variety	Co.	Beets/ Plot No.	Powdery Mildew Score 7/20	7/27	8/05	8/12	8/25	Mean
PM- 61	9BG6379	Beta	15.8	1.0	1.2	2.7	2.8	3.7	2.3
- 63	OBG6113	Beta	15.3	1.8	2.2	4.3	4.2	5.3	3.6
- 74	OBG6560	Beta	15.0	2.0	2.5	4.5	6.0	6.3	4.3
- 76	OBG6452	Beta	14.3	1.8	2.3	5.2	6.5	6.5	4.5
- 81	9BG6380	Beta	15.5	1.2	2.0	3.5	4.0	4.5	3.0
- 82	9BG6346	Beta	15.0	2.5	3.0	5.3	5.2	4.8	4.2
- 84	OBG6108	Beta	15.7	1.8	2.2	4.7	5.0	5.8	3.9
- 96	9BG6272	Beta	15.2	2.8	3.3	6.7	6.5	7.2	5.3
-100	OBG6175	Beta	16.0	2.3	3.3	6.0	6.2	6.5	4.9
-109	7BG6092	Beta	14.8	0.8	0.8	2.5	3.0	4.7	2.4
-111	4823	Beta	16.2	2.5	2.3	5.0	5.0	5.8	4.1
-112	9BG6374	Beta	14.5	0.5	1.0	1.8	2.5	3.5	1.9
-121	OBG6217	Beta	15.8	1.2	2.0	4.0	4.3	4.2	3.1
-122	OBG6430	Beta	15.7	0.7	1.2	3.8	4.0	4.8	2.9
-133	OBG6331	Beta	15.8	2.0	2.3	4.5	4.7	4.5	3.6
-140	OBG6134	Beta	16.3	2.0	2.2	4.8	4.5	4.8	3.7
-141	OBG6173	Beta	16.2	2.3	3.3	5.8	5.7	5.8	4.6
-142	OBG6109	Beta	15.8	2.2	2.7	4.7	4.5	4.2	3.6
-143	8BC6391	Beta	15.2	1.7	2.5	4.0	4.8	5.5	3.7
-144	OBG6178	Beta	15.8	2.3	3.0	5.7	5.5	5.2	4.3
-148	OBG6392	Beta	14.5	0.8	1.5	2.5	2.5	3.7	2.2
-153	1BG6119	Beta	16.2	0.5	1.0	2.5	3.7	3.0	2.1
-158	OBG6450	Beta	15.7	2.3	2.8	6.0	6.2	7.7	5.0
-171	9BG6371	Beta	16.2	1.8	2.2	3.7	4.3	4.5	3.3
-180	4757	Beta	16.2	0.3	1.0	2.3	2.8	4.2	2.1
PM- 1	90-88C11-09	Holly	15.3	1.8	3.7	6.5	6.8	7.2	5.2
- 13	90U 39R4/6-03	Holly	15.8	1.2	2.0	3.3	4.3	4.5	3.1
- 15	90C 63-04	Holly	15.0	2.0	2.5	4.8	4.5	4.8	3.7
- 18	HH-46	Holly	15.0	1.5	2.2	4.7	4.8	5.2	3.7
- 26	89-1459-042	Holly	14.8	1.7	2.7	4.7	5.2	5.0	3.8
- 28	90C 60-05	Holly	14.2	2.0	2.8	4.7	5.5	4.5	3.9
- 30	89-1459-082	Holly	15.7	2.7	3.2	6.2	6.7	6.8	5.1
- 33	90C 63-010	Holly	14.3	2.2	3.2	5.3	6.0	6.0	4.5
- 35	USC-1	Holly	16.2	1.7	2.7	4.7	5.5	5.7	4.0
- 36	90-87C34-06	Holly	14.0	2.7	3.7	7.0	7.5	8.0	5.8

TEST 1592. CODED POWDERY MILDEW TEST,
SALINAS, CA., 1992

(cont.)

Entry No.	Variety	Co.	Beets/ Plot No.	Powdery Mildew Score 7/20	7/27	8/05	8/12	8/25	Mean
PM- 44	90-1459-0114	Holly	15.8	2.0	2.0	3.5	4.0	4.3	3.2
- 50	90-1459-0184	Holly	15.2	1.7	2.3	4.7	5.3	4.5	3.7
- 53	HH-37	Holly	15.7	1.8	2.2	5.2	5.5	4.8	3.9
- 55	90C 64-05	Holly	14.5	1.3	2.0	5.2	5.5	5.3	3.9
- 56	90-1459-0189	Holly	16.0	2.2	3.0	5.5	5.7	5.2	4.3
- 57	HH-69	Holly	15.8	2.3	3.2	5.7	6.3	5.7	4.6
- 62	HH-84	Holly	15.3	2.5	2.7	4.8	5.0	5.7	4.1
- 66	HH-66	Holly	16.2	2.0	2.5	5.0	5.2	5.3	4.0
- 71	86-1459-038	Holly	15.7	1.8	3.2	5.3	5.2	5.2	4.1
- 72	87-1459-079	Holly	14.7	1.8	2.7	5.5	5.7	5.7	4.3
- 77	86C 15-014	Holly	15.7	2.3	4.0	6.5	6.7	6.7	5.2
- 79	89N 158-029	Holly	16.7	2.5	3.0	5.8	6.3	7.3	5.0
- 80	88-1459-049	Holly	17.0	3.2	3.7	6.8	7.7	6.3	5.5
- 83	90U 39R4/6-05	Holly	14.0	1.7	1.8	4.0	4.2	4.8	3.3
- 88	90C 63-016	Holly	16.0	2.2	3.2	6.8	6.5	6.7	5.1
- 89	89-1459-015	Holly	16.0	1.2	1.5	3.8	4.5	4.0	3.0
- 91	HH-55	Holly	15.3	1.0	1.8	3.5	3.7	4.2	2.8
- 92	HH-77	Holly	15.5	2.2	2.5	5.5	5.3	4.8	4.1
- 93	88C 144-04	Holly	15.3	2.0	2.8	5.7	5.3	5.3	4.2
- 95	90C 63-014	Holly	16.2	2.3	3.0	5.3	6.3	6.3	4.7
- 98	HH-85	Holly	17.0	1.8	2.2	4.5	5.0	4.8	3.7
- 99	89-1459-027	Holly	15.0	2.0	2.8	5.2	5.3	5.2	4.1
-103	90-1459-0112	Holly	16.2	2.3	2.7	5.0	5.5	5.2	4.1
-104	91-89C58-06	Holly	14.7	1.3	2.3	4.2	4.3	5.7	3.6
-105	90-1459-0161	Holly	15.8	2.3	2.8	5.8	6.0	6.7	4.7
-106	90-1459-0168	Holly	14.3	2.0	3.2	6.0	6.8	6.3	4.9
-113	90C 148-07	Holly	15.5	2.0	2.2	4.5	4.8	5.2	3.7
-115	90C 69-04	Holly	14.5	1.8	2.5	4.8	5.5	5.5	4.0
-118	90-88C11-02	Holly	15.7	2.3	2.7	4.7	5.0	5.5	4.0
-119	90C 148-06	Holly	15.0	1.8	2.3	4.3	4.5	4.3	3.5
-125	HH-56	Holly	15.2	2.0	2.8	4.7	5.0	5.5	4.0
-129	89C 58-07	Holly	16.0	2.7	3.3	6.8	6.2	6.8	5.2
-132	90C 62-011	Holly	16.0	2.5	2.7	7.0	6.5	7.3	5.2
-134	90C 63-015	Holly	15.8	1.7	2.7	5.0	5.2	5.0	3.9
-136	90C 148-031	Holly	15.7	2.5	2.7	5.7	4.8	5.0	4.1
-137	89C 58-03	Holly	15.3	3.2	2.8	6.3	6.7	6.5	5.1
-138	91C 143-07	Holly	15.3	1.7	2.3	4.7	4.8	5.2	3.7
-139	90-88C11-010	Holly	15.3	2.3	2.7	5.7	5.5	5.5	4.3
-145	90-1459-0176	Holly	16.2	2.2	3.0	6.3	6.8	7.2	5.1
-146	HH-38	Holly	15.7	1.5	2.0	3.5	3.7	4.7	3.1

TEST 1592. CODED POWDERY MILDEW TEST,
SALINAS, CA., 1992

(cont.)

Entry No.	Variety	Co.	Beets/ Plot No.	Powdery Mildew Score 7/20	7/27	8/05	8/12	8/25	Mean
PM-147	HH-45	Holly	16.3	1.0	2.0	3.3	3.8	5.0	3.0
-149	HH-81	Holly	15.8	2.7	3.2	5.5	6.3	6.3	4.8
-151	89N 158-015	Holly	15.3	1.8	2.5	4.8	5.3	7.2	4.3
-156	Rhizosen	Holly	15.7	2.0	2.3	4.7	4.7	6.2	4.0
-161	89C 58-010	Holly	15.5	1.7	2.3	4.0	4.7	4.7	3.5
-164	86-1459-026	Holly	15.7	1.8	2.5	4.5	4.5	4.8	3.6
-168	90C 148-05	Holly	16.2	1.5	2.5	4.7	4.8	5.3	3.8
-170	HH-41	Holly	15.8	1.7	2.3	4.3	4.3	4.7	3.5
-175	90C 64-03	Holly	13.3	1.2	2.2	4.7	5.2	5.5	3.7
-176	90-1459-0108	Holly	16.0	1.7	2.7	4.8	5.0	5.2	3.9
-177	HH-79	Holly	14.7	2.7	3.5	6.5	6.7	6.0	5.1
-178	89-1459-026	Holly	14.8	2.0	2.8	5.5	4.8	5.7	4.2
PM- 10	HM 3025	Hill-MH	15.8	2.5	2.8	6.3	5.8	6.3	4.8
- 17	HM 6036	Hill-MH	16.3	1.8	2.2	4.3	4.3	4.3	3.4
- 29	HM 3024	Hill-MH	16.0	1.3	1.8	3.5	4.5	4.5	3.1
- 34	HM 3014	Hill-MH	16.0	1.2	1.7	3.5	4.0	4.5	3.0
- 46	HM 3013	Hill-MH	14.2	2.0	2.7	4.7	5.5	5.3	4.0
- 47	HM 3019	Hill-MH	14.3	1.7	2.2	4.2	4.8	5.3	3.6
- 49	Hill 2	Hill-MH	14.8	1.2	1.3	3.8	5.3	5.7	3.5
- 65	HM 5330	Hill-MH	15.8	1.8	1.8	4.0	3.7	4.0	3.1
- 85	HM 3029	Hill-MH	15.7	2.3	2.8	6.5	6.3	7.5	5.1
- 94	HM 3005	Hill-MH	16.0	1.5	2.7	5.2	5.3	5.8	4.1
- 97	HM 3030	Hill-MH	15.5	2.0	2.5	5.0	5.2	5.0	3.9
-114	HM 6027	Hill-MH	15.3	2.0	2.5	4.3	5.2	4.8	3.8
-120	HM 3012	Hill-MH	15.5	2.3	3.0	5.7	5.8	4.5	4.3
-124	HM 3022	Hill-MH	16.0	2.5	3.0	6.0	5.5	6.2	4.6
-126	HM 3023	Hill-MH	16.7	2.2	3.2	6.5	6.5	6.2	4.9
-157	HM 3016	Hill-MH	15.8	1.7	1.7	3.8	4.7	5.2	3.4
-173	HM 3020	Hill-MH	15.5	2.2	3.0	6.5	6.8	7.7	5.2
- 39	USH-11	Check	15.3	2.7	3.3	6.5	6.7	6.2	5.1
-101	USH-11	Check	15.7	2.7	3.7	7.0	6.8	6.0	5.2
-116	USH-11	Check	15.3	2.3	3.0	6.0	6.0	5.7	4.6
-123	USH-11	Check	15.0	2.8	4.0	6.5	6.5	6.2	5.2

TEST 1592. CODED POWDERY MILDEW TEST,
SALINAS, CA., 1992

(cont.)

Entry No.	Variety	Co.	Beets/ Plot No.	Powdery Mildew Score 7/20	7/27	8/05	8/12	8/25	Mean
Checks included by USDA									
PM-181	USH-11		15.7	2.5	3.0	5.7	6.0	6.2	4.7
-182	USH-11		16.0	2.5	3.5	6.5	6.5	6.3	5.1
-183	USH-11		16.0	2.2	3.0	5.5	5.8	6.0	4.5
-184	USH-11		15.2	2.7	3.2	6.7	5.3	6.2	4.8
PM-185	WS-PM-9		15.0	0.3	0.7	2.0	2.2	1.8	1.4
-186	WS-PM-9		15.8	0.7	0.8	2.0	2.2	1.3	1.4
-187	WS-PM-9		16.2	0.2	0.5	1.3	1.7	1.3	1.0
-188	WS-PM-9		14.8	0.3	0.7	1.3	1.3	1.7	1.1
PM-189	C39		13.2	0.2	0.5	1.5	2.5	3.0	1.5
-190	C39		14.0	0.0	0.3	1.0	1.0	2.0	0.9
-191	C39		12.3	0.2	0.5	1.2	1.5	1.7	1.0
-192	C39		13.8	0.0	0.5	1.2	1.3	1.7	0.9
Mean			1.9	2.5	4.8	5.2	5.5	4.0	
LSD (.05)				1.2	1.1	1.8	1.5	1.5	1.1
C.V. (%)	58.1	40.3	32.4	25.6	23.5	25.2			
F value				2.1**	3.6**	4.5**	5.8**	6.3**	6.3**

Footnote: Powdery mildew scored on a scale of 0 to 9, where 9 = 90-100% of visible leaf area infected. Mean value (area under disease progress curve) most likely represents varietal reaction and differences among varieties. Scoring was stopped when most susceptible entries and US H11 started having lower values.

TEST RZM 192. 1992 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1992

64 entries x 3 reps, RCB
1-row plots, 10 ft. long

Planted: June 5, 1992
Natural infection to BWYV
Harvested: November 24, 1992

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 10/03	#62 CLS[7]	#66 PM[8]	#74 Rhizomania[9] DI	#74 Rhizomania[9] %H	#81 Beet Cyst Nematode[10]
Ames 10836	China	56	7	1	2	1	2	3.3	3.0	3.3	5.7	12.5	3
Ames 10837	China	51	7	1	2	1	2	3.7	4.3	3.7	6.0	19.6	3
Ames 10838	China	55	7	1	2	1	2	3.0	3.0	2.7	6.3	1.8	3
Ames 10839	China	69	7	1	2	1	2	4.3	3.0	2.3	5.3	17.4	3
Ames 10840	China	52	7	1	2	1	2	3.7	4.7	4.0	6.2	9.6	3
Ames 10841	India	---	8	1	2	4	1	---	---	---	---	---	---
PI 504196	Italy	---	8	2	2	6	1	---	---	---	---	---	---
PI 504199	Italy	---	8	2	2	4	1	---	---	---	---	---	---
PI 504205	Italy	---	8	2	2	4	1	---	---	---	---	---	---
PI 504206	Italy	---	8	2	2	4	1	---	---	---	---	---	---
PI 504225	Italy	---	8	2	2	4	1	---	---	---	---	---	---
PI 504240	Italy	---	8	2	2	4	1	---	---	---	---	---	---
PI 504246	Italy	---	8	2	2	4	1	---	---	---	---	---	---
PI 504248	Italy	---	8	2	2	4	1	---	---	---	---	---	---
PI 504250	Italy	---	8	3	2	4	1	---	---	---	---	---	---
PI 504251	Italy	---	8	3	2	4	1	---	---	---	---	---	---
PI 504266	France	---	8	2	2	4	1	---	---	---	---	---	---
PI 504268	France	---	8	1	2	4	1	---	---	---	---	---	---

TEST RZM 192. 1992 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1992

(cont.)

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 10/03	#62 CLS[7]	#66 PM[8]	#74 Rhizomania[9] DI	#74 Rhizomania[9] %H	#81 Beet Cyst Nematode[10]
PI 504270	France	---	8	2	2	4	1	---	---	---	---	---	---
PI 504271	France	---	8	1	2	4	1	---	---	---	---	---	---
PI 504273	France	---	8	2	2	4	1	---	---	---	---	---	---
PI 504276	France	---	8	1	2	4	1	---	---	---	---	---	---
PI 504277	France	---	8	2	2	6	1	---	---	---	---	---	---
PI 504279	France	---	8	2	2	4	1	---	---	---	---	---	---
PI 504281	France	---	8	2	2	4	1	---	---	---	---	---	---
PI 504282	France	---	8	1	2	4	1	---	---	---	---	---	---
PI 504284	France	5	8	2	2	4	3	3.0	3.0	1.0	3.4	80.0	---
PI 504285	France	20	6	2	2	4	1	1.0	3.0	1.0	4.1	50.0	---
PI 518319	U.K.	58	6	1	2	4	2	1.0	3.7	0.7	3.4	75.9	2
PI 518320	U.K.	59	6	1	2	4	2	1.7	4.0	1.0	4.2	38.9	3
PI 518321	U.K.	66	6	1	2	6	2	1.7	4.7	0.0	4.1	45.5	3
PI 518341	U.K.	78	6	2	2	4	3	3.0	3.0	0.3	4.1	47.4	3
PI 518362	U.K.	56	6	1	2	6	2	3.3	3.0	1.7	4.6	32.1	3
PI 518407	Ireland	37	6	2	2	4	3	2.7	4.0	0.0	3.7	64.9	2
PI 518428	U.K.	63	5	1	2	4	2	3.0	4.3	2.0	4.4	39.7	3
PI 518432	U.K.	70	5	1	2	4	2	1.7	4.6	4.3	4.2	41.4	3
PI 518434	U.K.	52	5	2	2	4	3	1.7	4.3	4.3	4.9	21.2	3
PI 518437	U.K.	57	5	1	2	4	2	1.7	4.3	2.0	4.8	24.6	3
PI 518438	U.K.	57	5	1	2	4	2	1.3	4.3	3.0	4.8	19.3	3
PI 518439	U.K.	55	5	1	2	4	2	1.3	4.0	3.0	4.9	25.5	3
PI 546509	Greece	---	8	1	2	4	1	---	---	---	---	---	---
PI 546510	Greece	---	8	2	2	4	1	---	---	---	---	---	---

TEST RZM 192. 1992 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1992

(cont.)

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 10/03	#62 CLS[7]	#66 PM[8]	#74 Rhizomania[9] DI	#74 Rhizomania[9] %H	#81 Beet Cyst Nematode[10]
PI 546513	Italy	3	7	2	2	4	1	3.0	3.0	2.0	6.3	0.0	---
PI 546524	Italy	6	7	2	2	6	1	5.0	5.0	1.0	5.7	0.0	---
PI 546526	Italy	---	8	2	2	4	1	---	---	---	---	---	---
PI 546527	Italy	---	8	2	2	6	1	---	---	---	---	---	---
PI 546529	Italy	---	8	2	2	4	1	---	---	---	---	---	---
PI 546530	Italy	---	8	2	2	4	1	---	---	---	---	---	---
PI 546531	Italy	---	8	1	2	4	1	---	---	---	---	---	---
PI 546532	Greece	---	8	1	2	4	1	---	---	---	---	---	---
PI 546533	Greece	---	8	2	2	4	1	---	---	---	---	---	---
PI 546535	Greece	40	7	2	2	1	3	4.3	4.5	0.7	7.1	0.0	3
PI 546536	Greece	19	7	2	2	4	3	5.5	3.5	1.5	7.3	0.0	3
PI 546537	Greece	16	7	2	2	4	3	4.7	2.7	0.7	7.5	0.0	3
PI 546538	Greece	18	7	2	2	1	3	5.0	1.7	0.0	7.9	0.0	3
PI 546539	Greece	24	7	2	2	6	3	2.7	4.5	2.0	7.3	4.2	3
PI 552532	USA-ND	55	7	1	2	6	2	5.3	5.3	5.0	6.0	10.9	3
PI 558513	USA-CO	48	7	2	2	6	2	5.7	5.0	3.7	6.9	0.0	3
PI 558514	USA-CO	40	7	1	2	1	2	4.3	5.7	4.3	6.8	0.0	3
PI 558515	USA-CO	57	7	1	2	1	1	4.0	5.3	3.0	6.6	1.8	3
USH11	USDA	68	5	1	2	1	2	2.7	6.3	4.7	6.5	5.9	3
R139C7	USDA	86	5	1	2	1	2	2.0	4.0	1.0	3.1	77.9	3
1913	USDA	75	5	1	2	1	2	1.7	4.0	5.0	4.5	38.7	3
SP 7622-0	USDA	43	5	1	2	1	2	4.3	4.0	6.3	6.6	4.7	3

TEST RZM 192. 1992 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1992

(cont.)

[1] #1 End use based upon field plot appearance where: 1=chard; 2=DDR-like; 3=DDR, chard, spinach; 4=fodder; 5=sugar; 6=wild beet type; 7=mixed, 8=annual.

[2] #5 Population Uniformity: 1=all plants alike; 2=uneven different types; 3=mixed, green, red, yellow, high, low, large leaves, small leaves, etc.

[3] #12 Mature Leaf Blade Pigmentation: 1=light green (chard), 2=green, 3=red & green, 4=red, 5=mutant.

[4] #19 Petiole Color: 1=green, 2=pink, 3=red, 4=candy stripe, 5=yellow, 6=mixed.

[5] #37 Bolting Tendency without cold induction: 1=B-(annual)=100%, 2=bb(biennial)-0%, 3=B:bb(mixed) 1-99%.

[6] #61 Beet Western Yellows (BWYV): 0=immune; 1=very resistant; 3=resistant; 5=intermediate; 7=susceptible; 9=highly susceptible based upon yellowing of leaves. Mean disease ratings (DI) from Nov. 5, 1992.

[7] #62 Cercospora Leaf Spot scored 0 to 9 where 9 = defoliation.

[8] #66 Powdery Mildew scored 0 to 9 where 9 = 90-100% of leaf area covered with mildew. PM very light.

[9] #74 Rhizomania: DI-disease index based upon 0=no visual symptoms; 1=very minor root symptoms; 3=normal tap root, slight bearding; 5=wine-glass shaped, bearded, moderate damage; 7=severly damaged, loss of tap root; 9=dead due to rhizomania %Healthy=classes (0+1+2+3)/total.

[10] #81 Beet Cyst nematode: Natural infection in field and visual rating at harvest where: 1=Nematode res.; 2=Nematode Susc.; 3=Seg.

64 entries = 60 PI lines from Ames plus checks. Checks are: US H11=highly susc. to rhizomnania, mod. susceptible to BWYV; C39 (R139C7) = moderately resistant to BWYV and rhizomania; 1913 = mod. resistant to BWYV and rhizomania; SP7622-0 = susceptible to BWYV and rhizomania.

Conclusion: Roots within some lines of B.maritima showed resistance to rhizomania. Individual plants were selected and will be crossed to sugarbeet to determine the nature and inheritance of this resistance. Many of the B.maritima lines showed very mild symptoms to BWYV. The dark green, thick leaves of B.maritima have a tendency to mask virus yellows sypmtoms. No line or PI was found that was free of cyst nematode. Lines from Italy, France and Greece were too easy bolting for field tests to be valid.

RHIZOMANIA - THE BASIC NATURE OF THIS COMPLEX DISEASE

BSDF Project 203

J. E. Duffus, H. Y. Liu, G. C. Wisler and A. L. Pilgeram

The rhizomania disease as it occurs in various parts of the world must be viewed as a complex of virus entities, vectored by distinct *Polymyxa* biotypes or other root infecting organisms. At least seven distinct viral pathogens, some similar in particle morphology to beet necrotic yellow vein virus (BNYVV), the causal agent of rhizomania, and others with dissimilar particles, have been detected in California, Texas, Oregon, Idaho, Nebraska, Wyoming and Michigan growing areas. These new viruses have not been characterized as to relationships to rhizomania, distribution and the importance of the new viruses as they relate to host resistance and breeding for resistance to BNYVV.

The viruses associated with sugarbeet roots fall into at lease five families of plant viruses with virus particles ranging from long flexuous rods, to shorter stiff rods, to two types of spherical particles. Isolations and characterizations of new entities from north central U.S. along with previously isolated entities from California and Texas are continuing (note abstracts by Wisler *et al.* this report). A more complete report of the characterization and distribution of these viruses will be reported in the 1993 Sugarbeet Research.

Evaluation of Photosynthetic Parameters in the Selection of Varieties with Improved Rates of Sugar Production

Project 250

Professor Norman Terry, University of California, Department of Plant Biology, 111 GPBB, Berkeley, CA 94720

The goal of this research is to identify superior-yielding sugar beet genotypes using pulse-modulated fluorescence analysis. During the last year, we measured three parameters (q_E, $(F_v)_s$ and F_v/F_m) in young plants to see how well they could predict superior sugar-yielding genotypes among plants grown for a further 6 to 8 weeks. Despite some experimental setbacks, we successfully showed that selection for high values of $(F_v)_s$ and F_v/F_m, and for low values of q_E, identified plants which were later shown to have higher root sucrose content or % sucrose in the storage root. Furthermore, these results confirm those obtained in earlier years and they provide a strong basis of support for the view that selection for fluorescence parameters is a rapid, innovative and viable way of identifying plants with superior yield potential.

In order for plant breeders to use this approach to routinely screen for high-yielding plants, we need to optimize the experimental approach. During the last year's research we learned much about how to improve the methodology of using the fluorescence approach. For the next year's research, we propose to 1) cut the number of fluorescence parameters selected from 3 to 2 ($(F_v)_s$ and F_v/F_m), 2) increase the size of the selection sample and the total population of plants screened, and 3) to implement an improved experimental design to minimize competition between plants for light and nutrients. From this research we hope to speed the transfer of this sophisticated laboratory technology for use by plant breeders.

Project Accomplishments (October 1, 1992):

Introduction:

The overall goal of this research is to develop procedures for using chlorophyll fluorescence parameters (measured in young plants) to identify superior-yielding sugar beet genotypes. In previous years, we found three highly-promising fluorescence parameters, q_E, $(F_v)_s$ and F_v/F_m. This year we tested how well these parameters could predict which plants (in a population of young plants) would later have high sucrose yields or % sucrose.

Materials and Methods:

Fifteen replicate plants from each of 39 different sugarbeet seedlots (i.e., a total of 585 plants) were grown in 3 growth chambers (5 replicates of each seedlot per growth chamber) at 25°C with a photon flux density of 450 μmol m^{-2} s^{-1} supplied over a 16-hour day. The seeds sown in sand for two weeks and the germinated seedlings were transferred to half-strength Hoagland's solution for 2 more weeks. One third of the seed was sown in one growth chamber on April 14 (Set I), the second third on April 16 (Set II), and the final third on April 19 (Set III). The sowing was staggered over time to allow us 6 days (2 days per chamber) in order to complete the large number of fluorescence measurements which had to be made without changing the stage of growth of the plant. Two weeks after transplanting, we measured chlorophyll fluorescence of the attached leaves using the pulse modulation chlorophyll fluorometer Model PAM (H. Walz, Effeltritch, FRG).

Our objective was to increase the total number of plants from which selections were to be made (from 195 to 585), and, to increase the number of plants selected for each parameter (from 12 to 30). In order to grow this number of plants we had to use 3 growth chambers, i.e., in each growth chamber we grew 5 replicates of 39 seedlots, a total of 195 plants per chamber (Sets I, II and III, see above). These plants were grown in rectangular metal containers with 24 plants per container. Fluorescence parameters were measured on each set of 195 plants over 2 days. For each 195 plant set, we selected the plants exhibiting highest 5 and lowest 5 values for each parameter, i.e., q_E, $(F_v)_s$ and F_v/F_m. This gave from 24 to 27 plants total per chamber. The plants were supposed to be grown for 6 more weeks. However, we accidentally harvested the Set I plants last instead of first so that these plants were grown for 56 days after selection rather than 42. Set II plants were harvested 49 days after selection and Set III, 43 days after selection. Furthermore, because selection for the highest 5/lowest 5 values gave more plants than we anticipated, we had to place two plants per 20-liter container in the growth period following selection. We believe that both these departures from the planned experimental protocol may have resulted in experimental errors (discussed below).

At harvest, we measured root sucrose contents, and the fresh and dry weights of various plant parts. Statistical correlations between the fluorescence parameters and root sugar contents were determined.

Measurement of chlorophyll fluorescence

Chlorophyll fluorescence emission from the top side of the most rapidly expanding attached leaf was measured using a pulse modulation fluorometer (Model PAM, H. Walz, Effeltrich, FRG, including a PAM 101 control unit, the 101 ED emitter-detector unit, the 101 F fiberoptics, the PAM 103 accessory module unit, and the FL 101 fiberilluminator). The terminal end of the optical fiber bundle (which provides actinic light, the measuring beam and conducts the fluorescence emission to the detector) was in close contact with the upper surface of the leaf. The measurement proceeded as follows: plants were first illuminated for about 2 hours in the growth chambers, then they were dark-adapted for 20 minutes. The minimal fluorescence level, F_o, was taken as the fluorescence intensity of the dark-adapted leaf after the measuring light was switched on (0.05 μmol PFD m^{-2} s^{-1} modulated at 1.6 kHz). The maximal fluorescence level, F_m, was induced by applying a saturation light pulse of 4000 μmol PFD m^{-2} s^{-1}, 800 ms in duration. After another 20 s, when the signal had relaxed to near F_o, brief saturating pulses of actinic light (4000 μmol m^{-2} s^{-1}, 800 ms in length) were applied repetitively for 30 s with 2 s dark intervals. The photochemical and non-photochemical quenching components (q_Q, q_E, F_v, $(F_v)_m$, $(F_v)_s$) were determined from the fluorescence/time curve (i.e., changes occurring in initially dark-adapted then light-pulsed leaf) using the equations of Schreiber (1986).

Results:

Selection for high $(F_v)_s$

Despite the fact that the experiment was not executed as planned, the results are surprisingly encouraging. For example, young plants exhibiting high values for $(F_v)_s$ were later shown to have significantly higher sucrose yields and % sucrose values in their storage roots. This is illustrated in Table 1: in the first column, we show the seedlot number and the replicate plant chosen (e.g., in 4B.3, 4B is the seedlot number and .3 represents the third of 5 replicates). In the second column, we show the value of the fluorescence parameter in the 2-week old plants at the time of selection. The remaining columns provide information on the 8-week old plants at the time of harvest. The results show that selection for high versus low $(F_v)_s$ measured on 2-week old plants resulted in similar storage root sizes, but 36% more sucrose per root and a 32% increase in % sucrose (Table 1). Because of the small number of plants (10), only the % sucrose values were statistically significant ($P = 0.05$). If all of the data of the Set I plants (i.e., all plants in the growth chamber) are considered, we obtained a statistically significant correlation for both % sucrose and total root sucrose (Fig. 1a,b,

Table 10).

As noted in the Materials and Methods there was an error made in the harvesting times of the plants of Sets I, II, and III. These three sets of plants were supposed to be replicates but actually represent three sets of data for plants which were at different stages of development, i.e., 43, 49 and 56 days of growth after selection for Set I, II and III, respectively. This is shown in Fig. 2. Storage root dry weight and root sugar content increased significantly with time from 43 to 56 days while the rate of shoot growth was slowing down over this period. Because the three sets of plants differed from one another, their data are considered separately.

Examination of the data for Set II plants shows selection for high values of $(F_v)_s$ in young plants identified plants which were later shown to have significantly (17%) higher % sucrose values in their storage roots (Table 2). Selection for high $(F_v)_s$ in Set III plants produced plants exhibiting a 2-fold increase in storage root size and root sugar content, but, owing to the high variability associated with a small sample size, the results were not statistically significant (Table 3).

Selection for low q_E

The data for the q_E parameter are shown in Tables 4 (Set I), 5 (Set II) and 6 (Set III). Selection for low q_E in the Set 1 and Set II plants resulted in higher % sucrose values but the differences were not statistically significant (Tables 4 and 5, respectively). In Set III, selection for low q_E yielded plants with 59% larger storage roots and with 67% higher root sugar content (Table 6). Due to the high variability the data were not statistically significant. However, if the data from all the Set III plants are combined, a statistically significant correlation between q_E and root sugar content was obtained (Table 10, Fig. 1c).

Selection for high F_v/F_m

The data for the F_v/F_m parameter are shown in Tables 7 (Set I), 8 (Set II) and 9 (Set III). Selection for high F_v/F_m was successful in yielding plants with 69% higher root sucrose content (significant at P = 0.05, Tables 9 and 10) in Set III plants. In Set I plants, selection for high F_v/F_m yielded plants with 43% higher total sucrose content but the variability of the data was too high for statistical significance (Table 7).

Conclusions

1. Progress-To-Date:

The results are encouraging in that selection for each of these fluorescence parameters was successful in identifying plants which had either higher root sucrose content (high $(F_v)_s$ and low q_E) or higher % sucrose (high $(F_v)_s$) or both (high $(F_v)_s$)

(Table 10). Furthermore, the fluorescence predictors operated in the same direction as in previous years, i.e., high root sucrose yield and % sucrose were correlated with selections for high values of $(F_v)_s$ and F_v/F_m and with low values of q_E. The fluorescence parameters were also correlated significantly with each other (Table 10) in ways identical to those obtained in previous years. It would appear therefore that these three fluorescence parameters together reflect a part of the photosynthetic-photosynthate partitioning system which is responsible for increasing root sugar yields. However, we encountered experimental difficulties which are enumerated below.

2. Sample size:

We did not succeed in increasing the sample size at selection from 12 to 30 as we had hoped because of differences among the 3 "replicate" sets of plants (i.e., Sets I, II and III) resulting from different growth durations (43, 49 or 56 days for Sets I, II and III) in each chamber. Furthermore, Set II plants experienced a growth chamber breakdown for approximately 72 hours during which time the lights failed to come on properly during the light period. This occurred over a weekend and the plants had to be transferred to a new chamber. Thus, the selection size was reduced to 10 plants (5 for the 5 highest fluorescence values and 5 for the lowest values) for each set of plants.

3. Overcrowding:

After selecting the top 5 and bottom 5 plants for each of the three fluorescence parameters, we obtained more plants per growth chamber than we had expected (from 24 to 27 plants per chamber). Thus, in order to fit the large number of selected plants in the growth chamber, we put two plants in each container. With hindsight we realize that this was not a good idea: 1) the faster growing plant in each container shades the slower growing plant, and 2) the faster growing plant takes the larger share of the mineral nutrients. Mutual shading between plants in the growth chamber decreases photosynthetic rate and therefore affects % sucrose and total sucrose stored in the root. Thus, plants selected for a given fluorescence parameter cannot develop to their full potential if they happen to be shaded by a neighboring plant. This, and competition for mineral nutrients between plants, are likely to dramatically increase experimental variability.

4. Testing period:

The results also suggest that 6 weeks may not be long enough to test the hypothesis that improvement in sugar % and yield can be obtained by selection for fluorescence parameters. We obtained better results when we inadvertently grew the plants for 56 days rather than 43 or 49 days. Since the tap roots are rapidly increasing in sugar content during the period from 6 to 8 weeks (see Fig. 1), we believe that the testing period should be extended to 8 weeks.

Table 1: Values of $(F_v)_s$, root sucrose content, % sucrose and storage root dry weight for Set I plants with the 5 highest and 5 lowest values of $(F_v)_s$ at selection time. The correlation coefficients are for $(F_v)_s$ at selection time (column 2) with each of the parameters at harvest time (columns 3 to 5).

Seedlot/ replicate number	$(F_v)_s$ at time of selection	gms sucrose per plant	% sucrose in storage roots	storage root dry wt.
Top Five Plants				
4B.3	**3.115**	55.1	10.7	78.5
4B.2	**3.055**	46.8	10.9	72.8
3B.2	**3.040**	43.4	11.9	60.3
5B.5	**2.915**	64.1	9.1	92.1
11A.2	**2.910**	15.0	9.0	22.9
Average	**3.007**	44.9	10.3	65.3
s.d.	**0.091**	18.5	1.25	26.3
Lowest Five Plants				
17A.5	**2.105**	23.2	10.2	37.7
5A.4	**2.105**	44.8	9.5	74.0
2A.4	**2.090**	10.6	7.8	17.3
1A.2	**1.995**	44.5	4.3	108.4
23A.1	**2.160**	42.1	7.1	74.3
Average	**2.091**	33.0	7.8	62.3
s.d.	**0.060**	15.4	2.31	35.5
Corr.Coef.(r)	1.00	0.382	0.674*	0.049

r value at 5% level of significance = 0.6319

Table 2: Values of $(F_v)_s$, root sucrose content, % sucrose and storage root dry weight for Set II plants with the 5 highest and 5 lowest values of $(F_v)_s$ at selection time. The correlation coefficients are for $(F_v)_s$ at selection time (column 2) with each of the parameters at harvest time (columns 3 to 5).

Seedlot/ replicate number	$(F_v)_s$ at time of selection	gms sucrose per plant	% sucrose in storage roots	storage root dry wt.
Top Five Plants				
5B.07	**3.190**	42.3	7.8	69.4
6B.06	**3.075**	24.1	8.7	39.4
7B.06	**3.070**	21.3	8.5	30.2
8B.09	**2.980**	28.4	7.7	41.6
13A.06	**2.950**	10.2	8.3	17.8
Average	**3.053**	25.2	8.2	39.7
s.d.	**0.094**	11.7	0.44	19.1
Lowest Five Plants				
11B.06	**2.275**	37.5	7.1	59.9
8A.08	**2.260**	18.3	5.9	31.9
8A.10	**2.255**	12.5	7.7	18.8
6A.10	**2.200**	16.7	7.5	26.0
10B.10	**2.110**	34.7	7.0	60.8
Average	**2.220**	23.9	7.0	39.5
s.d.	**0.068**	11.3	0.70	19.6
Corr.Coef.(r)	1.00	0.124	0.722*	0.061

r value at 5% level of significance = 0.6319

Table 3: Values of $(F_v)_s$, root sucrose content, % sucrose and storage root dry weight for Set III plants with the 5 highest and 5 lowest values of $(F_v)_s$ at selection time. The correlation coefficients are for $(F_v)_s$ at selection time (column 2) with each of the parameters at harvest time (columns 3 to 5).

Seedlot/ replicate number	$(F_v)_s$ at time of selection	gms sucrose per plant	% sucrose in storage roots	storage root dry wt.
Top Five Plants				
2B.15	**3.560**	17.0	8.4	32.4
24A.14	**3.160**	29.7	6.8	53.9
11A.13	**3.075**	12.9	5.8	24.1
11B.14	**3.030**	43.7	9.7	65.5
16A.13	**3.000**	31.5	7.3	61.5
Average	**3.165**	26.9	7.6	47.5
s.d.	**0.229**	12.3	1.5	18.3
Lowest Five Plants				
25A.15	**2.205**	27.9	5.2	57.5
20A.15	**2.190**	16.8	10.0	24.1
9B.13	**2.165**	7.6	10.2	11.4
8A.13	**1.130**	7.5	7.5	13.9
9B.14	**2.035**	6.7	11.5	9.6
Average	**2.145**	13.3	8.9	23.3
s.d.	**0.068**	9.16	2.52	19.9
Corr.Coef.(r)	1.00	0.489	-0.329	0.507

r value at 5% level of significance = 0.6319

Table 4: Values of q_E, root sucrose content, % sucrose and storage root dry weight for Set I plants with the 5 highest and 5 lowest values of q_E at selection time. The correlation coefficients are for q_E at selection time (column 2) with each of the parameters at harvest time (columns 3 to 5).

Seedlot/ replicate number	q_E at time of selection	gms sucrose per plant	% sucrose in storage roots	storage root dry wt.
Top Five Plants				
1A.2	0.262	44.5	4.3	105.7
2A.4	0.301	10.6	7.8	14.0
8A.3	0.286	40.2	9.8	56.0
23A.1	0.286	42.1	7.1	71.0
8B.1	0.275	19.4	10.5	24.0
Average	0.282	31.3	7.9	54.1
s.d.	0.014	15.3	2.4	36.9
Lowest Five Plants				
25A.3	0.095	42.1	8.1	66.2
3A.2	0.094	30.6	9.3	44.5
9B.4	0.093	23.2	12.9	27.6
14A.1	0.090	24.0	8.6	33.9
11A.2	0.089	15.0	9.0	19.3
Average	0.092	27.0	9.6	38.3
s.d.	0.003	10.1	1.91	18.1
Corr.Coef.(r)	1.00	-0.148	-0.363	0.237

r value at 5% level of significance = 0.6319

Table 5: Values of q_E, root sucrose content, % sucrose and storage root dry weight for Set II plants with the 5 highest and 5 lowest values of q_E at selection time. The correlation coefficients are for q_E at selection time (column 2) with each of the parameters at harvest time (columns 3 to 5).

Seedlot/ replicate number	q_E at time of selection	gms sucrose per plant	% sucrose in storage roots	storage root dry wt.
Top Five Plants				
8A.08	0.271	18.3	5.9	31.9
10B.09	0.252	53.2	5.9	89.7
8A.10	0.206	12.5	7.7	18.8
12A.08	0.205	11.0	7.5	16.8
23A.06	0.199	36.2	6.9	54.6
Average	0.227	26.2	6.8	42.4
s.d.	0.033	18.1	0.86	30.4
Lowest Five Plants				
11B.08	0.090	25.6	7.7	40.9
5B.07	0.086	42.3	7.8	69.4
5B.08	0.082	31.8	6.0	67.2
3A.09	0.078	27.8	9.7	39.0
22A.07	0.073	10.7	6.0	19.1
Average	0.082	27.6	7.4	47.1
s.d.	0.007	11.5	1.54	21.1
Corr.Coef.(r)	1.00	0.035	-0.378	0.002

r value at 5% level of significance = 0.6319

Table 6: Values of q_E, root sucrose content, % sucrose and storage root dry weight for Set III plants with the 5 highest and 5 lowest values of q_E at selection time. The correlation coefficients are for q_E at selection time (column 2) with each of the parameters at harvest time (columns 3 to 5).

Seedlot/ replicate number	q_E at time of selection	gms sucrose per plant	% sucrose in storage roots	storage root dry wt.
Top Five Plants				
9B.14	0.301	6.7	11.5	9.6
8A.13	0.277	7.5	7.5	13.9
9B.13	0.238	7.6	10.2	11.4
17A.11	0.228	7.2	10.2	10.3
1A.14	0.226	38.3	7.9	61.7
Average	0.254	13.5	9.5	21.4
s.d.	0.033	13.9	1.7	22.6
Lowest Five Plants				
22A.15	0.081	8.0	7.6	14.2
15A.14	0.076	41.9	7.9	66.6
5A.15	0.075	11.9	8.5	19.5
7A.13	0.075	23.3	10.0	29.7
20A.13	0.058	27.6	6.9	40.6
Average	0.073	22.5	8.2	34.1
s.d.	0.009	13.5	1.17	20.8
Corr.Coef.(r)	1.00	-0.424	0.311	-0.387

r value at 5% level of significance = 0.6319

Table 7: Values of F_v/F_m, root sucrose content, % sucrose and storage root dry weight for Set I plants with the 5 highest and 5 lowest values of F_v/F_m at selection time. The correlation coefficients are for F_v/F_m at selection time (column 2) with each of the parameters at harvest time (columns 3 to 5).

Seedlot/ replicate number	F_v/F_m at time of selection	gms sucrose per plant	% sucrose in storage roots	storage root dry wt.
Top Five Plants				
11A.2	0.258	15.0	9.0	22.9
16A.2	0.281	40.9	8.1	69.5
10B.3	0.271	56.1	11.3	71.6
11B.4	0.267	44.7	11.1	60.8
14B.4	0.267	66.0	9.3	106.3
Average	0.269	44.5	9.8	66.2
s.d.	0.008	19.2	1.4	29.8
Lowest Five Plants				
11A.4	0.183	33.1	7.9	55.0
22A.4	0.182	23.2	9.3	35.4
1A.2	0.181	30.6	9.3	108.4
6A.1	0.179	24.5	7.3	43.7
5A.4	0.150	44.8	9.5	74.0
Average	0.175	31.2	8.7	63.3
s.d.	0.014	8.64	0.99	29.1
Corr.Coef.(r)	1.00	0.414	0.384	0.378

r value at 5% level of significance = 0.6319

Table 8: Values of F_v/F_m, root sucrose content, % sucrose and storage root dry weight for Set II plants with the 5 highest and 5 lowest values of F_v/F_m at selection time. The correlation coefficients are for F_v/F_m at selection time (column 2) with each of the parameters at harvest time (columns 3 to 5).

Seedlot/ replicate number	F_v/F_m at time of selection	gms sucrose per plant	% sucrose in storage roots	storage root dry wt.
Top Five Plants				
4A.06	**0.381**	27.1	5.2	55.6
8A.09	**0.371**	17.2	8.4	23.8
6B.06	**0.366**	24.1	8.7	39.4
3B.08	**0.293**	30.9	7.6	42.5
11B.07	**0.286**	27.5	6.7	45.5
Average	**0.339**	25.3	7.3	41.4
s.d.	**0.046**	5.14	1.4	11.5
Lowest Five Plants				
4A.09	**0.191**	33.4	7.2	50.0
10A.10	**0.183**	25.5	6.2	35.9
9B.10	**0.172**	25.2	8.5	43.1
5B.06	**0.153**	35.8	8.2	52.3
6A.10	**0.147**	16.7	7.5	26.0
Average	**0.169**	27.3	7.5	41.5
s.d.	**0.019**	7.60	0.90	10.7
Corr.Coef.(r)	1.00	-0.230	-0.119	-0.005

r value at 5% level of significance = 0.6319

Table 9: Values of F_v/F_m, root sucrose content, % sucrose and storage root dry weight for Set III plants with the 5 highest and 5 lowest values of F_v/F_m at selection time. The correlation coefficients are for F_v/F_m at selection time (column 2) with each of the parameters at harvest time (columns 3 to 5).

Seedlot/ replicate number	F_v/F_m at time of selection	gms sucrose per plant	% sucrose in storage roots	storage root dry wt.
Top Five Plants				
18A.12	**0.363**	23.4	5.8	45.6
4A.13	**0.339**	36.1	7.9	58.6
10B.14	**0.282**	39.2	6.9	75.7
22A.13	**0.274**	38.2	8.5	52.4
21A.12	**0.270**	24.9	6.2	44.1
Average	**0.306**	32.4	7.1	55.3
s.d.	**0.042**	7.62	1.13	12.8
Lowest Five Plants				
4A.11	**0.185**	14.9	5.5	33.9
4A.12	**0.178**	26.1	5.4	55.5
21A.15	**0.175**	21.5	8.1	35.0
21A.11	**0.171**	21.6	6.5	35.1
12B.11	**0.149**	11.9	9.1	17.4
Average	**0.172**	19.2	6.9	35.4
s.d.	**0.014**	5.70	1.63	13.5
Corr.Coef.(r)	1.00	0.632*	0.090	0.602

r value at 5% level of significance = 0.6319

Table 10: Correlation coefficients among fluorescence parameters and selected growth and yield attributes.

	Sugar (%)	Total sugar (g/plant)	Root dry wt. (g)	q_E	$F(v)_s$	F_v/F_m
			Set I			
Sugar %	1.000	0.064	-0.261	-0.378	0.456*	0.279
Total sugar		1.000	0.919*	-0.302	0.443*	0.381
Root dry wt.			1.000	-0.131	0.212	0.205
q_E				1.000	-0.639*	-0.653
$F(v)_s$					1.000	0.570
F_v/F_m						1.000
			Set II			
Sugar %	1.000	-0.181	-0.335	-0.213	0.214	-0.033
Total sugar		1.000	0.957*	0.057	0.040	-0.094
Root dry wt.			1.000	0.046	0.045	-0.035
q_E				1.000	-0.594*	-0.306
$F(v)_s$					1.000	0.435
F_v/F_m						1.000
			Set III			
Sugar %	1.000	-0.243	-0.439*	0.376	-0.297	-0.190
Total sugar		1.000	0.953*	-0.424*	0.356	0.394
Root dry wt.			1.000	-0.409*	0.366	0.396
q_E				1.000	-0.755*	-0.400
$F(v)_s$					1.000	0.441
F_v/F_m						1.000

* Significant at P=0.05.

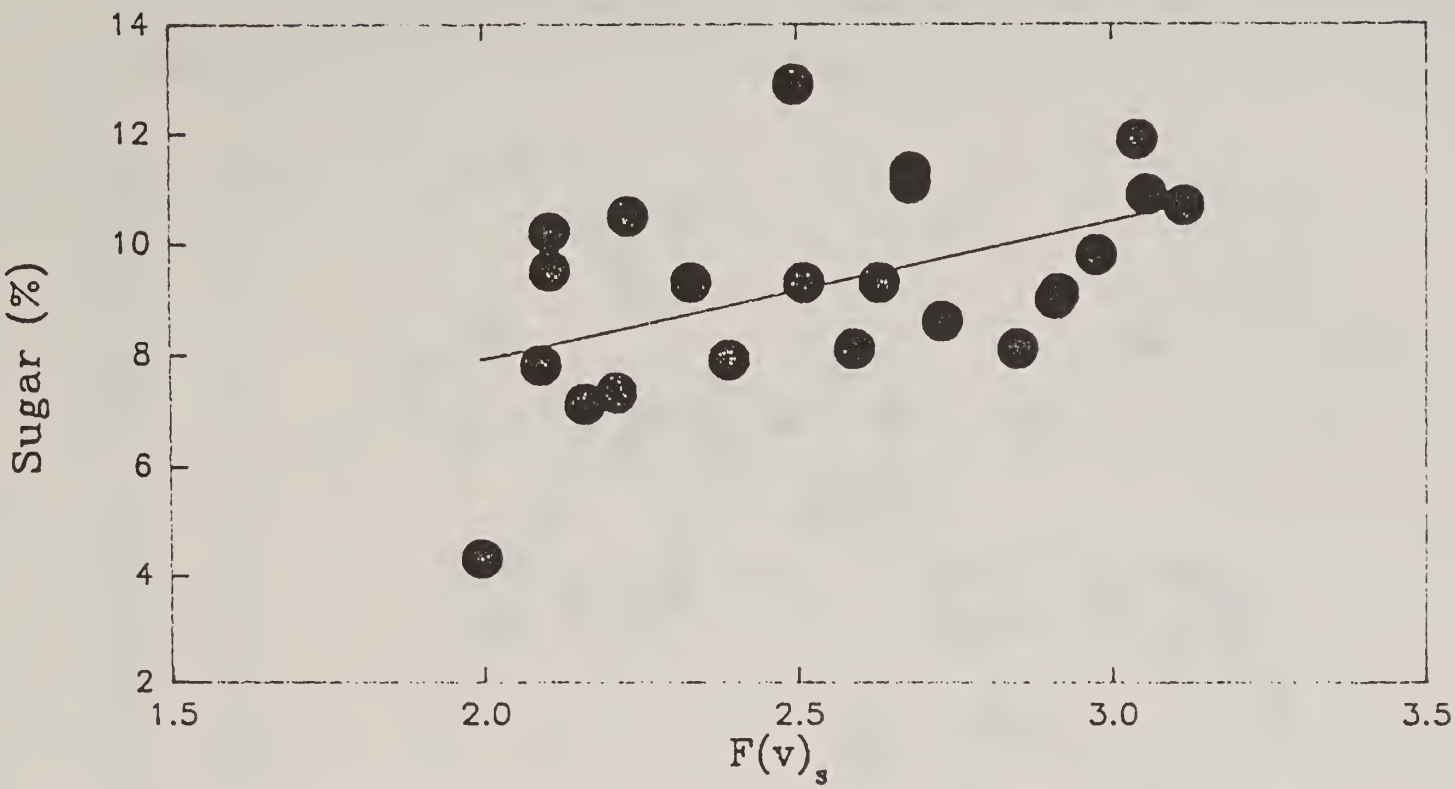

Fig. 1a : Relationship between $F(v)_s$, measured at selection time, and storage root percentage sugar at harvest time, eight weeks later, (set I plants).

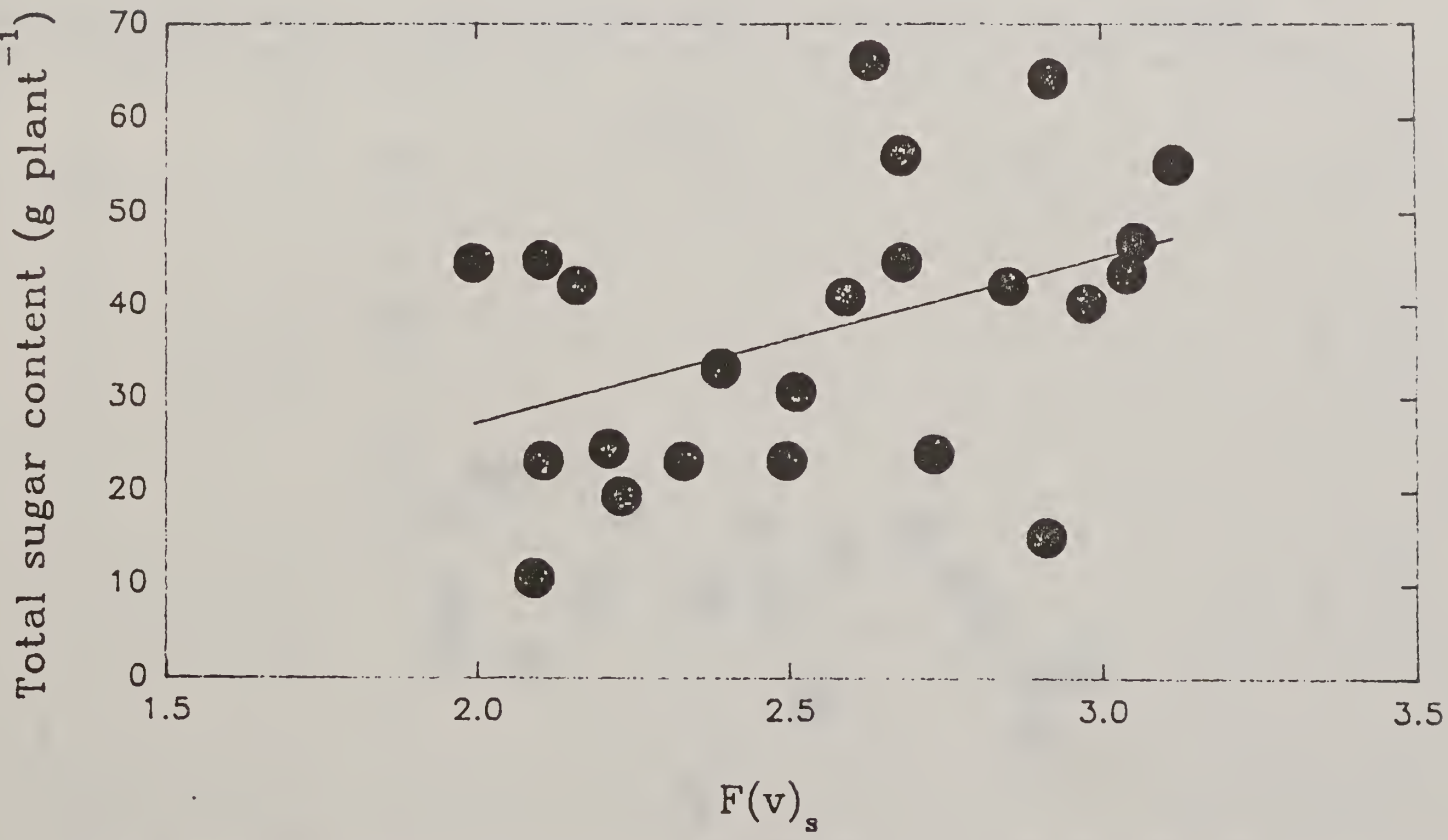

Fig. 1b : Relationship between $F(v)_s$, measured at selection time, and total sugar content in storage root at time of harvest, eight weeks later, (set I plants).

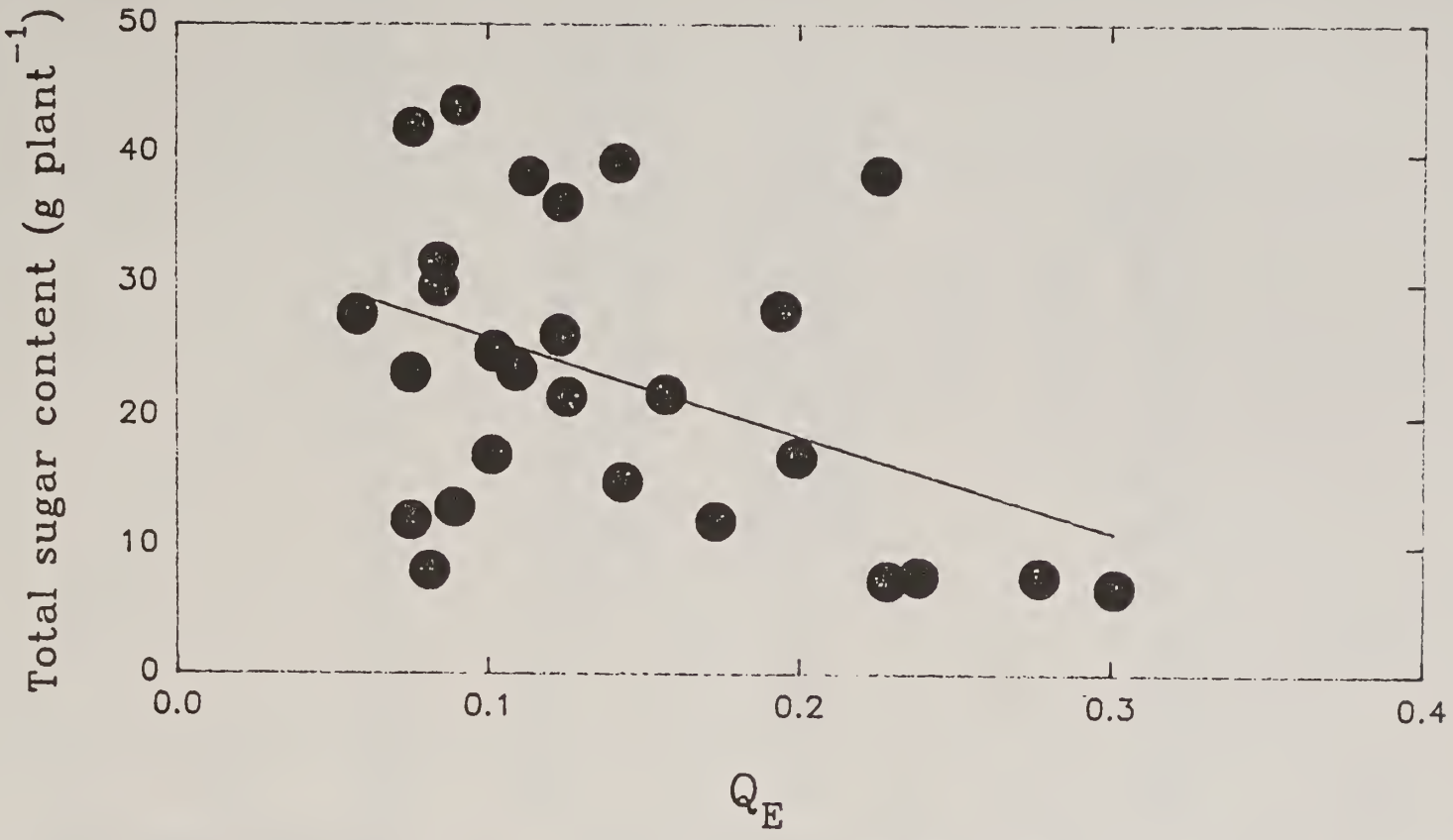

Fig. 1c : Relationship between q_E, measured at selection time, and total sugar content in storage root at time of harvest, six weeks later, (set III plants).

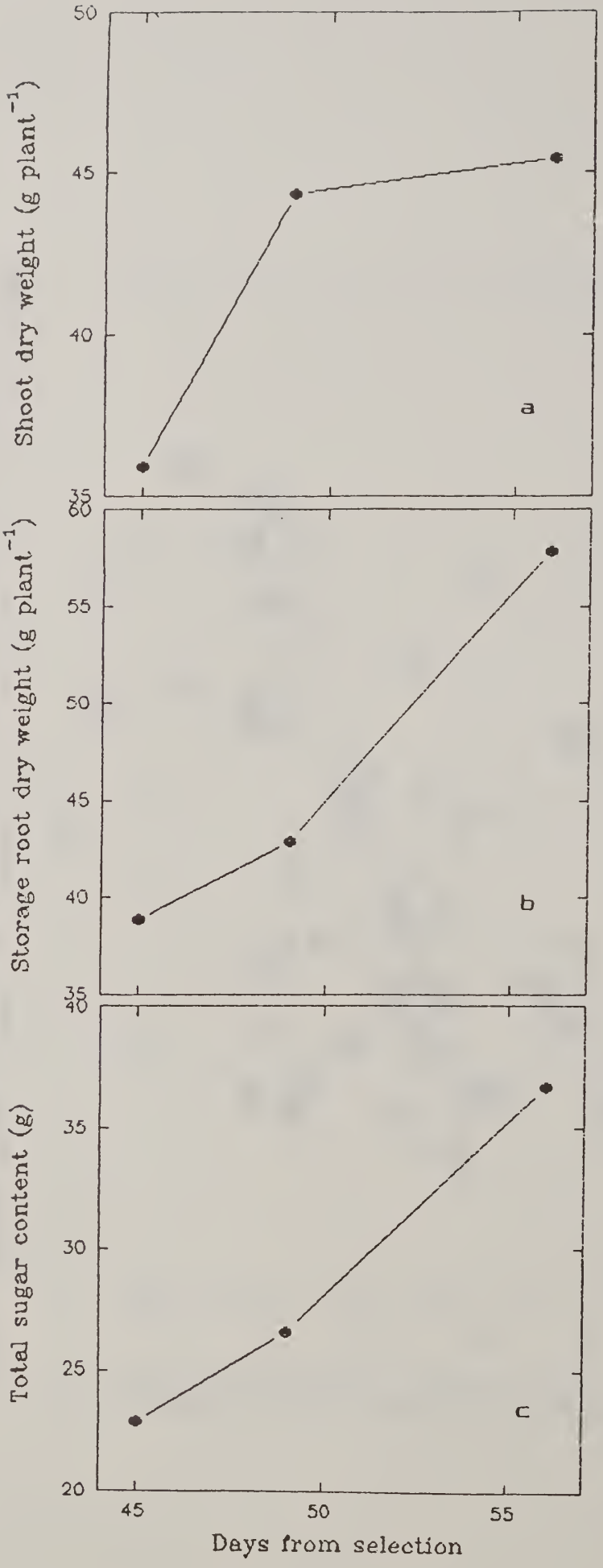

Fig. 2: Influence of the length of growth period after selection on a) total shoot dry weight, b) total storage root dry weight, and c) total storage root sugar content

SUGARBEET RESEARCH

1992 Report

Section B

Plant Molecular Biology Laboratory
Agricultural Research Service
United States Department of Agriculture
Beltsville, Maryland

Dr. Lowell D. Owens, Plant Physiologist
Dr. Russell O. Nordeen, Molecular Biologist
Dr. John Ingersoll, Molecular Biologist

The research was supported in part by funds provided through the Beet Sugar Development Foundation (Project 800)

CONTENTS

Hassan, M., S. L. Sinden, R. S. Kobayashi, R. O. Nordeen and L. D. Owens. 1992. *Acta Hort.* (In press).

Leaf discs and microtuber slices of two potato cultivars were co-cultivated with *Agrobacterium tumefaciens* LBA4404 containing an antibacterial gene, cecropin, fused to a plant secretory signal sequence cloned into the binary vector pBI121. Four regenerants of 'Atlantic' and eight of 'FL1607' exhibited kanamycin resistance. Transformation of these 12 lines was confirmed by histochemical assays for β-glucuronidase activity in leaves and tubers. Bacterial challenge experiments with potato tuber soft rot pathogens, *Erwinia carotovora* subsp. *carotovora* and *E. corotovora* subsp. *atroseptica* revealed a moderate (10-20 %) decrease in maceration among the transformed lines compared to cultivar controls. However, because only a limited number of greenhouse-grown tubers were tested, further testing, including tests of field-grown tubers, is necessary to identify individual transformed lines with resistance.

Nordeen, R. O., and L. D. Owens. 1992. Introduction and transcription of an antibacterial cecropin gene in tobacco plants. Suppl. to Plant Physiol. 99:47.

We are investigating the feasibility of introducing a modified cecropin gene into plants for protection against bacterial pathogens. Cecropins are a family of small basic polypeptides (ca. 4 kD) that possess potent antibacterial activity and are important in the immune response of insects. A DNA sequence encoding a modified form of the mature cecropin polypeptide was fused to a barley α-amylase secretory sequence DNA by PCR (polymerase chain reaction) and introduced into tobacco (*Nicotiana tabacum*) by transformation with *Agrobacterium tumefaciens*. The progeny of transformed plants that were resistant to kanamycin were analyzed for β-glucuronidase (GUS) and cecropin gene expression. Northern hybridization analysis indicated that about 75% of the R_1 plants produce a transcript of the expected size that hybridized specifically with a cecropin gene probe. Most of these plants also tested positive for GUS. Production and stability of cecropin polypeptide is currently being analyzed.

Huang, Y., J.H. McBeath, H. Lockwood and L. Owens. 1992. Expression of cecropin B controlled by plant inducible promoters in transgenic tobacco plants confers enhanced resistance to *Pseudomonas solanacearum*. Phytopathol. Abstr. 82:1101.

The function of promoters of phenylalanine ammonia-lyase (PAL) from *Arabidopsis* and proteinase inhibitor II (PiII) from potato in response to *P. solanacearum* infection was investigated in transgenic tobacco plants carrying gene fusions of PAL-beta-glucuronidase (GUS) and PiII-GUS. Activation of the PAL gene occurred in a localized area, and induction of PiII exhibited a systemic response. Each of the two promoters was fused to the gene encoding cecropin B, a lytic peptide that confers anti-bacterial activity. To facilitate secretion of the cecropin B into the extracellular fluid, the N-terminal signal sequence of barley alpha-amylase

was fused to the upstream of the cecropin B gene by PCR. The triple chimeric gene fusions were cloned into a binary vector and transformed into tobacco plants. Several transgenic lines were identified with resistance to *P. solanacearum* infection as evaluated by stem and root inoculation. Molecular characterization of the transgenic lines will be discussed.

Owens, L. D., R. O. Nordeen, and J. C. Ingersoll. 1992. Design and testing of novel genes for defense against sugarbeet pathogens. ASSBT Abstr. (In press)

New sources of resistance to microbial pathogens are needed for sugarbeet. As part of a program to develop novel defense genes for introduction into sugarbeet we investigated the feasibilty of engineering the cecropin gene for protection against bacterial pathogens. Cecropins are a family of small (4kD) bacteriocidal polypeptides that are important in the immune response of insects. Lethal concentrations of cecropin SB37 to *Erwinia carotovora* subsp. *betavasculorum* ranged from 1.2 to 2.8 μM, depending on the strain, while for sugarbeet protoplasts the value was 41 μM. These differences in relative toxicities suggest this approach may be feasible. A DNA sequence encoding a modified form of the mature cecropin polypeptide was fused to a secretory sequence from a barley α-amlyase gene and introduced into tobacco. The R_1 progeny of selfed transgenic plants were shown by northern hybridization analysis to contain cecropin messenger RNA, but efficacy against bacterial challenge has yet to be demonstrated. In related studies, using GUS (β-glucuronidase) fusion constructs and microparticle acceleration techniques, a promoter from a class 5 pathogensis-related (PR) protein gene of tobacco was more efficiently expressed in sugarbeet leaf tissue than the 35S promoter from cauliflower mosaic virus.

Papers Published Since Abstracted in Previous Report

Hatfield, D., C. I. Soon, S. Mischke and L. D. Owens. 1992. Selenocysteyl-tRNAs recognize UGA in *beta vulgaris*, a higher plant, and in *Gliocadium virens*, a filamentous fungus. *Biochem. Biophys. Res. Comm.* 184:254-259.

Nordeen, R.O., S. L. Sinden, J. M. Jaynes and L. D. Owens. 1992. Activity of cecropin SB37 against protoplasts from several plant species and their bacterial pathogens. *Plant Sci.* 82: 101-107.

Owens, L.D. and D. R. Eberts. 1992. Sugarbeet leaf disc culture: an improved procedure for inducing morphogenesis. *Plant Cell Tiss. Org. Cult.* 31:195-201.

Owens, L.D. 1992. Measurement of water availability in gel-solidified culture media. (Letter to the Editor) *Agricell Repts.* 18:11.

ENGINEERED RESISTANCE TO BACTERIAL PATHOGENS
BSDF Project 800

L. D. Owens and R. O. Nordeen

Testing of cecropin gene constructs in tobacco and potato plants - Some plants are known to produce, in response to fungal infections, small polypeptides that are lytic to hyphal-tip membranes. Although similar polypeptides that are lytic to bacterial pathogens have yet to be isolated from plants, they have been found in insects. One such example are the cecropins, a family of small polypeptides (~40 amino acids in length) that possess potent antibacterial activity and are important to the immune response of insects.

To construct a cecropin gene for use in plants, both natural and synthesized DNA sequences were used. A synthesized cDNA quivalent of the coding region of the cecropin B gene was fused to the secretory sequence from a barley α-amylase gene. The fused sequence was placed under control of either a tandem 35S promoter from cauliflower mosiac virus (35S-cecropin) or the promoter from a proteinase inhibitor II (PiII-cecropin) gene. These gene constructs were introduced into the model test plants tobacco and potato by *Agrobacterium tumefaciens*-mediated gene transfer. About three fourths of the R_1 plants transgenic for 35S-cecropin produced an mRNA transcript that hybridized with a cecropin gene probe. There was a fair correspondence between levels of GUS expression and the amount of cecropin transcript, probably reflecting the inherent transcriptional activity of the chromosomal site of T-DNA integration.

R_1 tobacco plants were tested for enhanced disease resistance by inoculation with the wilt-inducing bacterium *Pseudomonas solanacearum* . Preliminary results indicate an enhanced resistance with the PiII promoter construct. Tubers from potatoes transgenic for 35S-cecropin were challenged with potato tuber soft rot pathogens *Erwinia carotovora* subsp. *carotovora* and *E. corotovora* subsp. *atroseptica*.. A moderate (10-20 %) decrease in maceration was observed among the transformed lines compared to cultivar controls.

Attempts to introduce these cecropin gene constructs into sugarbeet are underway, but so far have been unsuccessful.

Degradation of cecropin by intercellular extracts from plant leaves - Previous studies indicated that cecropin was degraded by protease-like activity in intercellular extracts from leaves--but less so in extracts from sugarbeet than from tobacco leaves. In extracts from peach leaves, added cecropin (4 kD) appeared to undergo an endopeptidase cleavage, during the first three hours, yielding a 3-3.5 kD product which, in turn, was slowly degraded over the following 15 hours.

GENE DESIGN FOR SUGARBEET
J. Ingersoll and L. Owens

Promoter analysis in sugarbeet leaf discs - The cecropin and other engineered defense genes need to be efficiently expressed in sugarbeet in response to infection. In order to

study the efficiency of inducible promoters and accompanying 5'-untranslated leader sequences, various combinations of these elements were fused to the coding region of the *gusA* gene and amplified in *Escherichia coli*. DNA from these constructs was isolated and used to coat gold microparticles for use in microparticle acceleration experiments. 35S-GUS was used as the standard construct and leaf discs from shoot cultures of sugarbeet line Rel-1 as the target tissue. We found that culturing leaf discs for 3 to 4 days prior to bombardment resulted in a 20-fold increase in the number of blue foci obtained per disc as determined by the histochemical GUS assay 24 hours after bombardment. Using this optimized technique we found that a wound-inducible promoter from a class 5 pathogensis-related protein gene of tobacco, with its own 5' untranslated leader sequence, was expressed about 5 times more effeciently in sugarbeet leaf tissue than the constitutive 35S promoter from cauliflower mosiac virus.

SUGARBEET RESEARCH

1992 REPORT

Section C

Crops Research Laboratory, Agricultural Research Service
U.S. Department of Agriculture, Fort Collins, Colorado

Dr. Earl G. Ruppel, Plant Pathologist
Dr. Susan S. Martin, Plant Physiologist
Dr. Leonard W. Panella, Geneticist

Cooperation:

Colorado Agricultural Experiment Station

This research was supported in part by funds provided through the
Beet Sugar Development Foundation
(Projects 402, 903, and 904)

Contents

RHIZOCTONIA ROOT ROT RESEARCH AND DEVELOPMENT OF GENETIC RESISTANCE IN SUGARBEET
(BSDF Project 402)

1992 Field Research on Rhizoctonia Root Rot of Sugarbeet.--E. G. Ruppel.

Our project primarily involved field studies conducted on the Colorado State University South Campus in an area reserved for Rhizoctonia root rot research. Our Rhizoctonia research project is a cooperative effort of ARS, the BSDF, and Colorado State University. We are pleased to be able to lead this three-way cooperative research.

The 1992 field experiments were planted in an area that had been in barley for 3 years and was the site of our inoculated Rhizoctonia nursery in 1988. No Rhizoctonia root rot occurred from residual fungus before inoculation in 1992. As previously reported, rapid degradation of organic residues in our soil apparently reduced the soil population density of the fungus over the 4-year rotation schedule to a level insufficient to induce disease.

All Rhizoctonia evaluation experiments were planted in one-row plots 56 cm (22 in) apart and 6.1 m (20 ft) or 4.3 m (14 ft) long. Experiments were planted May 15 and thinned to an 20- to 25-cm (8- to 10-in) in-row spacing June 22-24. Dry, ground, barley-grain inoculum of *Rhizoctonia solani* (isolate R-9) was banded over the rows on July 21 at a rate of 8.4 g/4.3-m row and 18 g/6.1-m row with a tractor-mounted four-row granule applicator. Inoculum was banded in a split application, with opposite directions of travel for each application. One experiment involving our most resistant germplasms received the higher inoculum rate, whereas all other experiments received the lower rate. Our standard sprinkler irrigation regime was used to moisten and activate the inoculum. Succeeding irrigations were done by furrow.

Roots in all experiments were lifted September 21-22 and individually rated for rot on a disease index (DI) scale of 0 to 7, with 0 = no evidence of rot and 7 = plant dead. Percent healthy roots were those with DIs of 0 and 1, roots with no active infection. Roots with DIs 0 through 3 also were analyzed as a class; these roots were sufficiently sound and large to be recovered in a commercial harvest.

Although a greenhouse test before field application indicated a viable and highly virulent 1992 inoculum, the root rot epiphytotic in 1992 was extremely mild; across the nursery, DI means were only 0.7, 0.8, and 1.3 for highly resistant, resistant, and susceptible checks, respectively. Several factors attributed to the mild epiphytotic. First, frequent rains delayed inoculation by 1 week. Rains and exceptionally cool weather throughout the growing season also were not conducive to root rot development; night temperatures in late July and early August often were in the mid- to high 40s (fahrenheit), and a total of 29.2 cm (11.5 in) of rain was recorded over the growing season, which approaches our average annual rainfall. Our experience, and research conducted by John Gaskill, indicates that excessive moisture as rain or irrigation water tends to suppress Rhizoctonia root rot development. Further, the fungus is most active at temperatures of 26-32 C (79-90 F).

Germplasm Developments for Resistance to Rhizoctonia Root Rot.--L. W. Panella and E. G. Ruppel.

Several breeding lines were released for utilization by breeders and scientists mainly as sources of resistance to *Rhizoctonia* in the development of commercial hybrids. FC715 and FC715CMS were released because of their resistance to root-rotting strains of the fungus. FC716, FC717, FC718, and FC719 were developed from genetically different and unique sources and also are resistant to *R. solani*. Breeder seed will be maintained by ARS in Fort Collins and will be provided in quantities sufficient for reproduction upon written request.

Several other Rhizoctonia-resistant lines currently are under development. Five lines are being developed to combine resistance to *R. solani* and the curly top virus for incorporation by breeders in hybrids for use in areas where these diseases are endemic. Similarly, three lines are in various stages of development to combine resistance to *Rhizoctonia* and *Cercospora* for use in hybrids grown where these diseases are problems. Two lines are in development for high sucrose and resistance to *Rhizoctonia*, and two other lines are being developed to attain extremely high levels of resistance to the fungus. Some of these lines will be ready for release pending additional screening in our 1993 Rhizoctonia nursery.

In addition to the above germplasms, three lines, FC709, FC710, and FC712 were converted to tetraploidy by treatment with colchicine. These lines were released previously to breeders as diploids (2X), with high resistance to Rhizoctonia root rot and good combining ability. For use as parents in triploids, the added genome for resistance should increase the level of resistance to *Rhizoctonia* as previously reported. These germplasms may be available for release in approximately 2 years.

Future plans are for continued germplasm enhancement to combine resistance to *R. solani* with resistance to other sugarbeet pathogens, with greater attention to maintaining a genetic background of high commercial quality for use by industry and other sugarbeet breeders.

Potential of *Streptomyces griseoviridis* for Inhibition of *Rhizoctonia solani* In Vitro and for Suppression of Damping-Off in Sugarbeet.--E. G. Ruppel.

Streptomyces griseoviridis, isolated from peat in Finland, is a bacterium that is reported to act as a biocontrol agent against several pathogenic fungi encountered in greenhouse culture of plants. Although the agent has not been found in the U.S. and, therefore, cannot be tested in the field until registration is obtained, an experimental permit allowed testing against sugarbeet pathogens in the laboratory and greenhouse.

A dehydrated, commercial preparation of the bacterium was rehydrated to make a 0.1% (w/v) suspension, which was streaked on a *Streptomyces*-selective medium. When colonies developed, the bacterium was co-plated on potato-dextrose agar with *Rhizoctonia solani* (isolate R-9; AG-2-2); transfer plugs of the organisms were placed 3 cm apart. Within 24 hr, the leading edge of R-9 already exhibited slower growth due to inhibition by a substance(s) produced by the bacterium in advance of its growth. At 6 days, there was a 1- to 3-cm zone of inhibition surrounding the bacterial colony.

The dramatic inhibition of *R. solani* in vitro, prompted a test to determine if *S. griseoviridis* could suppress seedling damping-off caused by the fungus. A 0.1% (w/v) suspension of the bacterium was prepared, and 4-in pots of pasteurized soil were irrigated with 100 ml/pot. The treated pots were incubated for 72 hr when barley-grain inoculum of R-9 was incorporated at a rate of 0.5 propagules per gram soil. Treatments were: (1) *S. griseoviridis* alone; (2) sterile, ground barley grain plus *S. griseoviridis*; (3) sterile, ground barley grain alone; (4) *S. griseoviridis* plus R-9; (5) R-9 alone; and (6) nontreated control. Commercial sugarbeet cultivar MonoHy D-2 was planted in all pots, and seedling survival was recorded 21 days postplanting. Data are presented as the percent decreases in survival from the nontreated control. A final soil population density of *R. solani* was determined for treatments 4 and 5. A randomized complete block design was used with five replications in each of two trials; means of the two trials are presented (Table 1).

Table 1. Decrease in sugarbeet seedling survival as a percentage of control survival 21 days after soil amendment with *Streptomyces griseoviridis*, sterile barley grain, *Rhizoctonia solani*, or combinations of amendments

Amendment	% decrease in seedling survival[1]
1 *S. griseoviridis* (Sg)[2]	3
2 Sterile barley (ST)[3] + Sg	5
3 ST[3]	6
4 *R. solani*[4] + Sg[2]	55
5 *R. solani*[4]	61

[1]Decreases in survival for treatments 1, 2, and 3 reflects reduced emergence and not damping-off.
[2]100 ml of a 0.1% (w/v) suspension per 10-cm-diameter pot of soil applied 72 hr preplant.
[3]Soil concentration of barley grain was adjusted to that of colonized grain added for treatments 4 and 5.
[4]Applied as colonized, ground barley grain at a rate of 0.5 propagules of fungus per gram soil.

S. griseoviridis was ineffective in suppressing seedling damping-off of sugarbeet induced by *R. solani*. Final soil population densities of *R. solani* for treatments 4 (1.3 propagules/g) and 5 (1.9 propagules/g) were not significantly different. Because the bacterium produces an "inhibitory factor" in advance of its growth, normal irrigations applied to the pot cultures may have diluted the "factor" beyond effectiveness. A method to establish the bacterium in soil before planting (e.g., on colonized wheat bran) is being explored.

EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO RHIZOCTONIA ROOT ROT (BSDF Project 903)

E. G. Ruppel

Randomized complete block designs with five replications were used to evaluate a total of 171 contributed lines from six companies; additionally, one company also had another test of 12 lines with three replications. Rhizoctonia-resistant line FC703 and highly susceptible FC901 were included as internal controls, along with highly resistant FC705-1. The experimental design, methods, results, and statistical analyses were provided to the appropriate company breeders.

As already stated, the 1992 epiphytotic was extremely mild primarily due to adverse climatic conditions that prevailed during the growing season in Fort Collins. However, although disease indices (DIs) were low, differentiation was possible among highly resistant and highly susceptible lines. Mean DIs (scale of 0-7, with 7 = dead) for FC705-1, FC703, and FC901 controls were 0.7, 0.8, and 1.3, respectively. Percent healthy means were 95.7, 94, and 77.4 for these controls, respectively; percentages of roots in disease classes 0 through 3 were 99.3, 98.7, and 92.2, respectively. The lowest and highest DIs for contributor lines across tests were 0.5 and 2.9, respectively.

EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO CERCOSPORA LEAF SPOT (BSDF Project 904)

E. G. Ruppel

Randomized complete block designs with three replications were used to evaluate 221 lines from six contributors. Internal controls included a highly susceptible synthetic and a resistant check, FC(504 X 502/2) X SP6322-0. Two-row plots were 4.3 m (14 ft) long, with 56 cm (22 in) between rows and a 20- to 25-cm (8- to 10-in) within-row spacing. We inoculated twice (July 2 and 10), and evaluations were made on August 28, September 3, 9, and 17; the peak of the epidemic occurred around September 17.

The 1992 leaf spot epidemic progressed rather slowly at first due to a rain-delayed first inoculation and an unusually cool summer, but higher temperatures in August, coupled with our overhead irrigation to maintain high canopy humidity, induced a rapid disease progression during the latter part of August. By September 17, leaf spot severity was comparable to that of our August 27 evaluations in 1991. On September 17, means of the resistant and susceptible internal controls were 4.1 and 6.7 (increasing scale of 0-10), respectively, across the nursery. In 1991 (August 27), these means were 4.4 and 7.0, respectivley. Means of contibutor lines on September 17 ranged from 3.2 to 7.3, compared with 3.0 to 8.0 in 1991. Means of contributor tests were tabulated, statistically analyzed, and sent to the appropriate contributor.

SUGARBEET RESEARCH

1992 Report

SECTION D

Northern Crop Science Laboratory, Agricultural Research Service,
U.S. Department of Agriculture, Fargo, North Dakota

Dr. W. M. Bugbee, Plant Pathologist
Dr. L. G. Campbell, Geneticist
Dr. D. L. Doney, Geneticist
Dr. C. A. Wozniak, Molecular Biologist
Dr. G. A. Smith, Research Leader, Geneticist

Cooperation:

Colorado State University Experiment Station
North Dakota Agricultural Experiment Station
Sugarbeet Research and Education Board of
Minnesota and North Dakota

This research was funded in part by members of the Beet Sugar Development Foundation for support of Projects 600, 601, 610, 630, 631, 641 and 642.

CONTENTS

Abstracts of Papers Presented, Published, or Approved for Publication and Germplasm Registrations

BUGBEE, W. M. 1993. A pectin lyase inhibitor protein from cell walls of sugar beet. *Phytopathology* 83:63-68.

A protein was isolated from sugar beet roots that inhibits pectin lyase (PNL) from *Rhizoctonia solani*. This PNL inhibitor protein (PNLIP) was extracted from healthy sugar beet cell walls and partially purified by ammonium sulfate fractionation, cation exchange and gel permeation chromatography. Electrophoresis in polyacrylamide with sodium dodecyl sulfate showed a major single band 57.5 kD. Isoelectric focusing gave a major band at pI 9.9. Kinetic analysis indicated that the inhibition was uncompetitive (coupling). Pectin lyase inhibitory activity was greater in cell wall extracts from rotted and adjacent tissue than from healthy tissue. The inhibitor concentration was higher in root rot resistant germplasm than in a susceptible cultivar and was also higher in root than in hypocotyl or crown tissue. The inhibitor protected root discs from PNL damage in a buffered reaction mixture. The inhibitor was equally effective against PNL from *Phoma betae* but was less effective against PNL from *Aspergillus japonicus*.

CAMPBELL, L. G. and A. W. ANDERSON. 1992. Selection for sugarbeet root maggot resistance. *Annual Plant Resistance to Insects Newsletter* 18:47.

Sugarbeet root maggot (*Tetanops myopaeformis* Röder) populations have been high in recent years and insecticides have not provided consistent control. Accompanying the larger populations has been the spread of the root maggot into portions of the Red River Valley where they had not caused economic losses in the past. Developing host plant resistance to the maggot has been difficult. Sugarbeet (*Beta vulgaris* L.) breeding populations now in the program have a moderate level of resistance but lack sufficient resistance for use as parental lines for commercial hybrids. Two accessions (PI-179180 and PI-181718) from the USDA *Beta* collection have been identified as potential sources of root maggot resistance. These lines have a level of resistance comparable to lines that have been selected a number of generations. Both accessions have red, globe-shaped roots and are predominately biennial. PI-181718 is an introduction from Lebanon. PI-179180 originated from Turkey and has been characterized as resistant to Rhizomania (Beet necrotic yellow vein virus) and Erwinia root rot (*Erwinia carotovora* (Jones). Additional accessions from the *Beta* collection tentatively have been identified as resistant in preliminary screenings and will be evaluated further. The feasibility of utilizing tetraploid maggot resistant pollinators to produce triploid hybrids with commercially useful levels of root maggot resistance is being explored.

DONEY, D. L. 1992. International activities in *Beta* germplasm. *Agronomy Abstracts* p. 201.

Since 1983, all *Beta* germplasm activities in the U.S. have been coordinated by the Sugarbeet Crop Advisory Committee (CAC), a committee of the American Society of Sugar Beet Technologists (ASSBT). Until 1987, most of the international activities in *Beta* germplasm involved collection activities. Some collections were conducted as early as the 1920's. These early collections by Drs. G. Coons, D. Stewart and J. McFarlane were in cooperation with and shared with the host country. An international workshop in 1987 and the subsequent organization of the World *Beta* Network in 1989 have resulted in additional international germplasm activities. These include: 1) the development of an international descriptor list for *Beta*; 2) four systematic collection expeditions to collect wild species of *Beta* in Italy, Sardinia, Corsica, Ireland, United Kingdom, France, Belgium, Denmark and the USSR; 3) the development of an international data base for *Beta*; 4) the exchange of germplasm; and 5) international cooperation in seed multiplication. Future international efforts will include evaluation and enhancement activities.

DONEY, D. L. 1992. World *Beta* Network. *Sugarbeet Research and Extension Report* 22:279-281.

The World *Beta* Network was organized in 1989 with the objectives to: 1) bring scientists, curators, and interested parties together to review *Beta* germplasm resources activities and identify needs and gaps in activities, 2) plan and develop cooperative international *Beta* germplasm activities, and 3) provide technical reports and/or symposia sessions on germplasm research. The first World *Beta* Network workshop was held at Wageningen, The Netherlands, in 1989 with representatives from 17 countries present. Representatives from 19 countries met in 1991 at Braunschweig, Germany, for the second Network meeting. Activities to date have included: 1) the development and implementation of an international database (IDBB), 2) establishment of an international descriptor list for *Beta*, 3) identification of collection gaps and future cooperation efforts, 4) international cooperation in seed regeneration of endangered germplasm, 5) sponsored technical reporting sessions on *Beta* germplasm research, and 6) the development of an international evaluation proposal. The U.S. Sugarbeet CAC evaluation program will be implemented into this global approach to evaluation. The next meeting of the World *Beta* Network will be held in the summer of 1993 at Fargo, North Dakota.

PRODOEHL, K. A., L. G. CAMPBELL, and A. G. DEXTER. 1992. Phenmedipham+ desmedipham effects on photosynthesis, yield, and quality of sugarbeet. *Agronomy Journal* 84:1002-1005.

Phenmedipham+desmedipham (3-[(methoxycarbonyl)amino]phenyl (3-methylphenyl)carbamate plus ethyl [3-{[(phenylamino)carbonyl] oxy}phenyl]carbamate), is a herbicide which, by inhibiting photosystem II, controls broadleaf weeds in sugarbeet (*Beta vulgaris* L.). The herbicide also inhibits photosystem

II in sugarbeet, thus decreasing the photosynthetic activity. Field tests determined the quantitative effect of this herbicide on photosynthesis, root yield, and sucrose concentration of sugarbeet. Experiments were conducted at Fargo, North Dakota, in 1988, 1989, and 1990. Six commercial sugarbeet cultivars and two herbicide rates were studied. Photosynthesis was measured 1, 3, and 10 days after treatment (DAT). Photosynthesis was reduced by 50% and 30% 1 DAT with high and low rates, respectively. Photosynthetic rate recovered substantially by 10 DAT. Photosynthetic rate of the untreated plants remained nearly constant over the same 10-day period. Photosynthesis recovery did not differ between plants treated with the low or high rates of the herbicide. Root yields were reduced slightly by the herbicide, with the reduction being proportional to the rate of herbicide applied. Sucrose concentration was not influenced by phenmedipham+desmedipham.

SMITH, G. A. Biological control holds promise for control of serious sugarbeet pest. *Sugar Journal* (in press).

The sugarbeet root maggot is a major pest of sugarbeet affecting about 525,000 acres, or 40% of the U.S. growing area. One of the biological control approaches being investigated at the ARS Northern Crop Science Laboratory, Fargo, North Dakota, is the use of insect pathogenic nematodes. Six strains of these nematodes were all found to infect and kill the larvae of the sugarbeet root maggot. Adult flies were also infected and killed after only two hours of exposure to the nematodes. This is the first report of infection by pathogenic nematodes in any member of this insect family.

WOZNIAK, C. A. 1992. Occurrence of an immunorelated auxin-induced peptide in higher plants species. *Proceedings of the Third International Congress of Plant Molecular Biology*, Tucson, AZ, p. 842.

A peptide of approximately 27kDa in relative molecular mass (by 2-D PAGE) was found to accumulate concomitantly with auxin-induced callus formation in *Sorghum bicolor*. This callus-associated peptide (CAP1) accumulated to become the most abundant peptide in callus tissues as observed on silver stained 2-D gels. A 2-D PAGE screen of whole plant organs detected this peptide in crown tissues, but not in anthers, ovules, seeds, leaves, leaf sheaths, roots or stems of sorghum; this peptide was greatly enhanced in crowns following whole plant treatment with natural or synthetic auxins. A second callus-associated peptide (CAP2) was found to accumulate in callus which had lost the ability to regenerate. A polyclonal antiserum raised against purified CAP1 also reacted with this 44kDa peptide on 2-D immunoblots. Both peptides also bind Con A and are considered glycoproteins. This antiserum reacted with two bands of approximately 23kDa and 27kDa in etiolated coleoptiles of sorghum and maize as well. Examination of callus of other plant species revealed the presence of an immunorelated peptide of identical size (by SDS-PAGE/westerns) in 14 of 15 grass species evaluated; six cultivars representing the three subspecies of *Oryza sativa* failed to show any immunoreaction. The tribe in which rice is placed, the Oryzeae, is often considered an arbitrary grouping

of uncertain affinities. None of the 17 species of dicots or 4 species of non-gramineous monocots tested indicated the presence of any immunoreactive peptide. CAP1 is being evaluated for a possible role in auxin metabolism or binding and any taxonomic relevance it may have. EM localization and cDNA construction are being pursued.

WOZNIAK, C. A. 1992. Bacterial Flora of the sugarbeet root maggot. *Annual Plant Resistance to Insects Newsletter* 18:47-48.

The native microflora of third instar larvae of *Tetanops myopaeformis* Röder, the sugarbeet root maggot (SBRM), were sampled from four geographic locations where this insect is known to be endemic. Larvae were collected from sugarbeet fields during July and August of 1991 and transported on ice to the laboratory for analysis. Third instars were surface disinfested and homogenized in PBS. PBS was plated onto selective (medium XSNCI was modified to be specific for *Xanthomonas maltophilia* (Xm)) and non-selective (LB) media. Over 1000 isolates have been obtained to date. All samples contained Xm as part of the internal microflora. Other bacterial species were encountered from a portion of locations, but varied with origin of larvae. The role Xm may play in larval development or nutrition is being investigated through rearing of gnotobiotic larvae from disinfested eggs. Eggs plated on artificial diet hatched at similar rates regardless of microflora presence. Gnotobiotic larvae have been found to survive for long periods on axenic, transgenic root cultures of sugarbeet, but fail to moult. Addition of normal flora to these cultures is underway to determine the role of these bacteria in nutrition of developing larvae.

WOZNIAK, C. A. 1993. New directions in sugarbeet research. *Sugar Producer Magazine* 20:26-31.

The sugarbeet root maggot (SBRM) is the number one pest affecting sugarbeet production in many areas of the U.S. Insect control has been through the use of synthetic chemicals applied at planting to control larvae. Efficacy has been variable and biological methods are being explored for future use. Bacteria associated with insect gut and beet roots have been analyzed for their potential as vectors of toxins aimed at the SBRM. A bacterium, *Xanthonomas maltophilia* (Xm), has been found to be present on beet roots and within larval guts when samples from five states were analyzed. It is proposed that genetic manipulation of this microbe and subsequent reintroduction to the beet root zone will place a biopesticide specifically where it is needed. *Bacillus thuringiensis* (Bt) isolates were obtained from several environmental sources and are being evaluated for toxicity to the SBRM. Insect parasitic nematodes representing six strains were evaluated for their infectability to SBRM larvae and adults. Strong strain differences were observed with respect to larval mortality in lab studies. Adults were more susceptible to infection by all strains tested. Field plot analysis shows that SBRM larvae are susceptible to nematode infection under field conditions when applied at recommended rates.

Papers Published Since Abstracted in Previous Reports

CAMPBELL, L. G. 1992. Registration of four sugarbeet germplasms selected from the NC-7 *Beta* collection. *Crop Science* 32:1079.

DONEY, D. L. 1992. Morphology of North Atlantic *Beta*. IBPGR, International Crop Network Series 7:17-28.

DONEY, D. L. 1992. *Beta* genetic resources: North American activities. IBPGR, International Crop Network Series 7:32-40.

SMITH, G. A. and D. R. BUXTON. 1993. Temperate zone sweet sorghum ethanol production potential. *Bioresources Technology* 43:71-75.

BSDF PROJECT 600

DEVELOPMENT OF *CERCOSPORA* RESISTANT BREEDING LINES

G. A. Smith

Evaluations of a limited number of breeding lines were carried out at the ARS nursery located on Colorado State University land in Fort Collins. Included in the evaluations for 1992 were several versions of a leaf spot resistant multigerm line being developed for future release. This line, tentatively designated FC 907, is being developed as a pollinator line. The line also has moderate resistance to curly top. Release of this line has been delayed due to several seed "mix ups". The line continues to show high levels of resistance to *Cercospora* (rating = 3.5 - 4.0). Seed production attributes and limited combining ability evaluations are planned.

THE ASSOCIATION OF *CERCOSPORA* RESISTANCE AND YIELD IN COMMERCIAL HYBRIDS

L. G. Campbell and G. A. Smith

Maintaining or increasing the root yield and sugar concentration of new hybrids while incorporating useful levels of pest resistance is a constant challenge for commercial sugarbeet breeders. This task is especially difficult if the desired resistance is not simply inherited, as is the case with most sugarbeet diseases, including *Cercospora*. Although breeders recognize the general problem, its magnitude has not been adequately documented. Commercial yield trials are often planted at sites that avoid infection or diseases are controlled with chemicals. Under these conditions, neither the value of disease resistance in the absence of control measures nor the yield reduction associated with breeding for resistance is apparent.

Forty commercial hybrids, all recommended for growing in *Cercospora*-threat areas, were grown at Fargo, North Dakota (no *Cercospora*) and Fort Collins, Colorado in 1991 and 1992. The field at Fort Collins was inoculated with *Cercospora* and disease damage ratings recorded (Table 1). Root yield and sucrose concentration were measured at both Fort Collins and Fargo. A list of the 40 hybrids and a summary of the 1991 results were included in last year's "Blue Book" report (1991; pages D10 - D12).

The *Cercospora* epidemic in the Fort Collins nursery was more severe in 1992 than in 1991. Because of this, the increased root yield associated with increased *Cercospora* resistance observed at Fort Collins in 1991 was not as apparent in 1992 (Table 2). However, in both years, more resistant hybrids had generally higher sucrose concentrations at Fort Collins. In both years, root yields at Fargo were directly related to disease ratings. Regression of root yields on damage ratings indicated a 1.1 ton/acre increase for each increment increase (= reduced resistance) on the damage scale in 1992 (Fig. 1). This result and a similar value of 1.0

Table 1. *Cercospora* leaf spot ratings of 40 commercial hybrids, Fort Collins, Colorado, 1992 (0 = no symptoms to 10 = complete defoliation).

	Commercial Hybrids		Controls	
Date	Mean	Range	Susceptible	Resistant
	---------- disease rating ----------			
28 August	4.31	2.50 - 5.50	6.25	2.75
3 September	5.34	3.37 - 6.62	7.25	3.25
9 September	5.63	3.87 - 6.75	6.87	3.34
17 September	6.16	4.62 - 7.72	6.62	3.88

ton/acre observed in 1991 indicate that yield reduction has accompanied enhanced *Cercospora* resistance. There was no apparent relationship between level of *Cercospora* resistance and sucrose concentration in the *Cercospora*-free environment at Fargo. The spread of points about the regression lines indicated varying degrees of success in overcoming the negative association between resistance and root yield. Regression analysis indicated no relationship between root yield and damage rating under the milder *Cercospora* epidemic at Fort Collins in 1992, but did indicate a 1.3 ton/acre decrease for each increment increase in susceptibility in 1991. These differences are a direct reflection of contrasts in the value of resistance under varying disease severity.

Table 2. Correlation coefficients for *Cercospora* leaf spot damage ratings, root yield, and sugar concentration of 40 commercial hybrids grown at Fort Collins, Colorado and Fargo, North Dakota, 1992.

	Disease Rating			Root Yield		Sugar %	
	3 Sept	9 Sept	17 Sept	Fargo	Fort Collins	Fargo	Fort Collins
Disease Rating							
28 Aug	0.95**	0.87**	0.72**	0.70**	-0.01	-0.07	-0.48**
3 Sept	---	0.94**	0.83**	0.68**	-0.07	-0.08	-0.45**
9 Sept	---	---	0.91**	0.66**	-0.15	0.11	-0.26
17 Sept	---	---	---	0.46**	-0.17	0.18	-0.14
Root Yield							
Fargo	---	---	---	---	0.09	-0.03	-0.16
Fort Collins	---	---	---	---	---	-0.45**	-0.34*
Sugar %							
Fargo	---	---	---	---	---	---	0.66**

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

While differences between Fort Collins and Fargo involve more than the presence or absence of *Cercospora*, the patterns associated with locations and the consistency of trends over both years strongly suggests that *Cercospora* resistance had a major influence on relative productivity. The number of hybrids and breeding programs represented strengthen the validity of these conclusions. The results demonstrated that resistance is essential if *Cercospora* is present. It also provided a measure of the reduction in yield that has generally accompanied breeding for resistance when the more resistant hybrids are grown under no or low disease presence. The number of hybrids with relatively high damage ratings would suggest that in many breeding programs selection for *Cercospora* resistance is a low priority. The results quantify the dilemma faced by commercial breeders producing hybrids for regions where the occurrence and severity of *Cercospora* is unpredictable. It may be argued that enhancing root yield and sucrose concentration in the breeding program and recommending the occasional use of chemical fungicides would maximize grower profit. This logic does not recognize the importance of resistance in reducing disease severity on a regional basis. If resistant hybrids are planted throughout a region a few individuals may be able to grow susceptible hybrids successfully even though their widespread use might be disastrous. Also, ignoring resistance in a breeding program assumes that other control measures will always be effective and available. Evidence has already shown that *Cercospora* can be resistant to systemic and protectant fungicides. A detailed analysis and summarization of the results presented here will be submitted for publication in an appropriate journal.

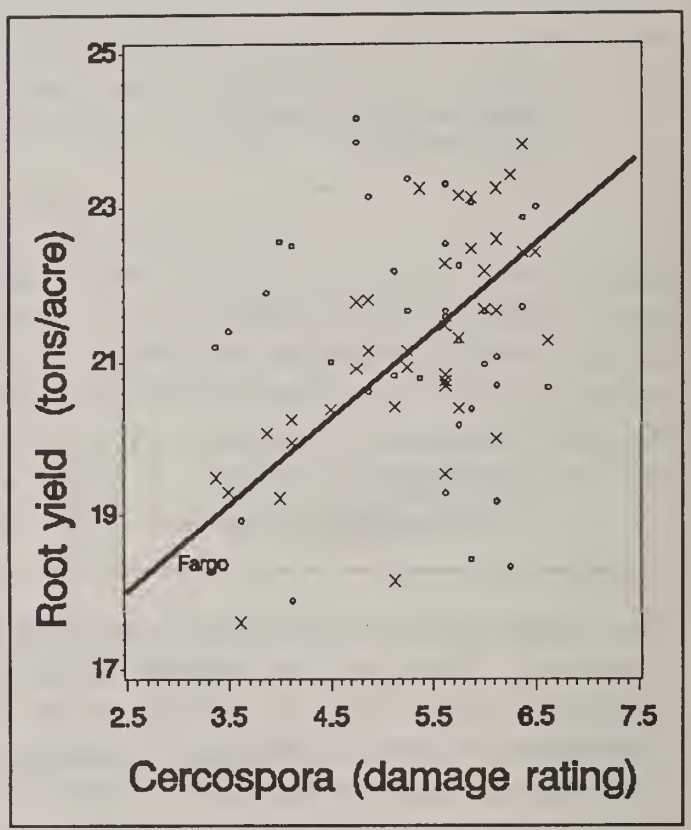

Fig. 1. *Cercospora* resistance vs. yield at Fort Collins, Colorado (o's) and Fargo, North Dakota (x's), 1992.

BSDF PROJECT 601

CERCOSPORA, ANTIFUNGAL BACTERIA, AND BIOPESTICIDE DEVELOPMENT RESEARCH

G. A. Smith and J. D. Eide

Examination of Bacteria (Agrobacteria) for Use in Transformation of Sugarbeet.--Agrobacterium tumefaciens has been the vector of choice for transformation of sugarbeet. Using *Agrobacterium* mediated transformation may be needed to deliver a gene or gene products active against sugarbeet root maggot (Diptera, *Tetanops myopaeformis*) and/or *Cercospora beticola*. In sugarbeet, this transformation method has not been routine and is difficult at best. We had

previously examined wild type *Agrobacterium* strains looking for highly virulent strains for use in our transformation program. None of the wild type *A. tumefaciens* were virulent. We are examining characteristics of virulent and nonvirulent *Agrobacteria* looking at total protein profiles separated by polyacrylamide gel electrophoresis (PAGE). Differences in protein banding patterns were observed between wild type isolates and known strains of *Agrobacteria*.

Virulence of *Agrobacterium* is determined by the presence of the tumor inducing (Ti) plasmid. The Ti-plasmid is an extrachromosomal piece of DNA containing a series of genes (*vir* genes) responsible for the virulent phenotype. Virulent *Agrobacterium* bound to plant cells induces the transcription of *vir* genes. We have obtained a 4.0 kilobase pair plasmid pSW104 containing the *virG* gene. Amplification of this plasmid was carried out in *Escherichia coli* GD32. We have purified the plasmid for use as a control in polymerase chain reaction (PCR) experiments. We have synthesized two 20 mer oligonucleotides *virG*294 and *virG*833 for use in PCR. Use of these oligonucleotides will determine the presence of the Ti plasmids in our *Agrobacterium* collection. We will continue to look for highly virulent *Agrobacteria* for use in our transformation program.

Antifungal Sugarbeet Rhizobacteria for Use as Endotoxin Gene Vectors.--Sugarbeets are known to harbor large numbers of bacteria on the root. This is a normal association and some of these bacteria may have disease fighting potential and/or growth promoting properties. We have previously isolated and identified hundreds of sugarbeet rhizospheric bacteria from many locations within the Red River Valley. Bacteria collected from Hillsboro, North Dakota were purified by successive single colony isolation. Identification was determined by gram stain and by the use of a Biolog 3N bacterial identification system. Biolog is a computerized bacterial identification system which identifies bacteria according to their ability to metabolize 95 different carbon sources. Forty bacteria were identified and tested for antifungal activity against the sugarbeet pathogens *Phoma betae*, *Pythium ultimum*, *Rhizoctonia solani*, *Aphanomyces cochliodes*, *Cercospora beticola*, and *Botrytis cinerea*. The bacteria *Serratia liquefaciens*, *Pseudomonas fluorescens*, and *Klebsiella terrigena* showed strong inhibition of all sugarbeet fungal pathogens (Table 1).

The bacterium *Klebsiella terrigena* had extremely strong antifungal activity. Bacteria in the genera *Serratia*, *Pseudomonas*, and *Klebsiella* are capable of enzymatic hydrolysis of chitin. Growth inhibition, in the presence of bacteria, may be due to high chitinase levels in the fungal cell walls. *Serratia* and *Pseudomonas* also have been found in the sugarbeet root maggot.

Effects of Bacteria on Sugarbeet Growth.--The antifungal sugarbeet rhizobacteria also were tested for growth promoting or inhibitory effects on sugarbeet seedlings. Twelve bacteria were chosen that showed antifungal activity against sugarbeet pathogens. Growth curves were calculated for the 12 antifungal bacteria using standard procedures. The absorbance units were calculated for 1×10^9 bacteria per ml. A hybrid sugarbeet cultivar was chosen for uniformity in plant growth. Seed of Van der Have hybrid 66156 was vacuum infiltrated with 20 ml of 1×10^9 bacteria per ml for 1 hour and allowed to air dry before planting. The experimental design was a split plot with 10 replications and 13 bacterial treatments. The main plot was ordered while the subplots and treatments were randomized. The subplots consisted of the vacuum infiltrated seed versus a bacterial drench with 20 ml of 1×10^9 bacteria per ml one week after planting. The

Table 1. Antifungal activity of sugarbeet rhizobacteria against sugarbeet fungal pathogens growth.

	Bacteria			
	Serratia liquifaciens	*Pseudomonas fluorescens*	*Klebsiella terrigena*	Control
Fungi	Growth (mm)			
Aphanomyces cochliodes	0	1	0	77
Botrytis cinerea	0	3	0	36
Cercospora beticola	0	0	1	31
Phoma betae	0	3	0	62
Pythium ultimum	10	9	0	37
Rhizoctonia solani	41	2	0	77

One ml of an overnight turbid suspension of bacteria was spread and allowed to dry on a Falcon 1029, 15 X 100 mm petri dish containing potato dextrose agar. One cm-diameter fungal plugs were placed in the middle of the petri dish. The diameter growth in millimeters was recorded after 7 days. The isolates were collected from Hillsboro, North Dakota.

experiment was conducted in the greenhouse. The treatments were as follows: 1 = unknown bacteria, 2 = *Enterobacter taylorae*, 3 = *Flavimonas oryzihabitans*, 4 = *Klebsiella ozaenae*, 5 = *Pseudomonas aurantiaca*, 6 = *Pseudomonas fluorescens* a, 7 = *Pseudomonas aurantiaca*, 8 = *Flavimonas oryzihabitans*, 9 = *Pseudomonas fluorescens* b, 10 = *Serratia liquefaciens*, 11 = *Pseudomonas fluorescens* b, 12 = *Serratia liquefaciens*, c = control (vacuum infiltrated or drenched with sterile 0.1 M potassium phosphate buffer). Fresh weights, dry weights, and stand counts were taken three weeks after planting.

Results.--Antifungal rhizobacteria showed some effects on sugarbeet seedling growth. Sugarbeet seedlings treated with *Pseudomonas fluorescens* (treatment 11) had significantly higher fresh weights than seedlings treated with *Pseudomonas aurantiaca* (treatment 5) (Fig. 1). Seedlings not treated with bacteria showed lower levels of growth as measured by fresh weight. This points to a trend toward a growth promoting effect with the addition of bacteria. Comparisons among bacteria for stand establishment of sugarbeet showed no significant differences. A greater number of sugarbeet seedlings were established using the vacuum infiltrated seed *vs.* the soil drenched seed (Fig. 2). The bacteria may have protected the seedlings from sugarbeet seedling disease. Placement of the bacteria into a seed treatment such as sodium alginate may

enhance the number and survival of the bacteria. We will look at methods for delivery of these bacteria to the seed and also continue to examine the effects of these antifungal bacteria on sugarbeet growth.

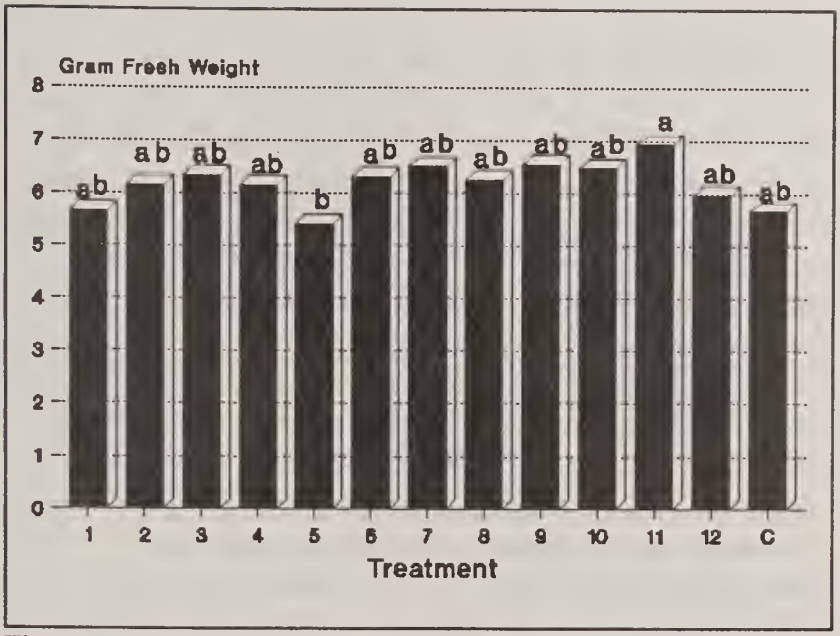

Fig. 1. Mean fresh weights of 3-week-old sugarbeet plants treated with different antifungal rhizobacteria. Bars with same letters are not significant using Duncan's multiple range test.

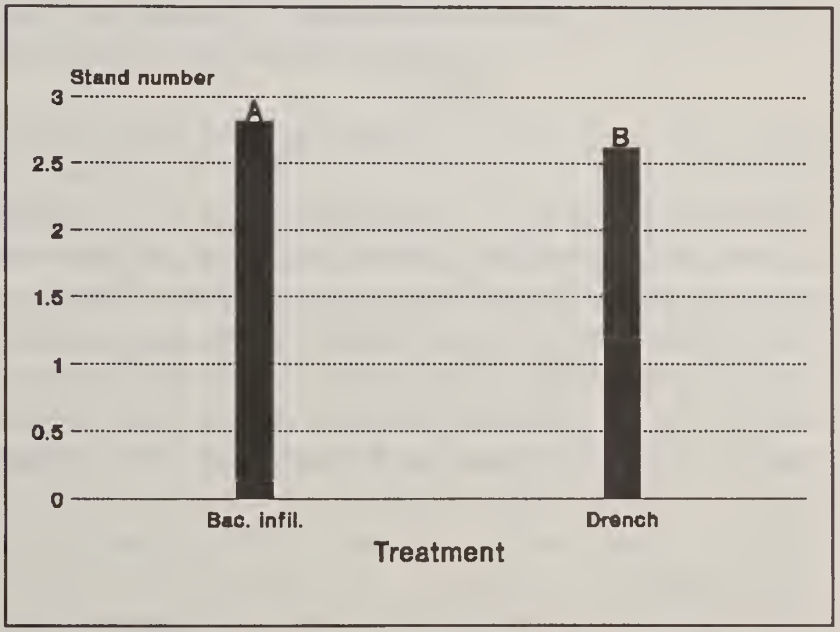

Fig. 2. Mean stands of sugarbeets vacuum infiltrated or soil drenched with antifungal rhizobacteria. Bars with different letters are significant using Duncan's multiple range test (P=0.05).

Examination and Purification of Chitinase in Cercospora Leaf Spot Susceptible and Resistant Material.--Chitinase is an enzyme that depolymerizes the chitin in fungal cell walls. We have looked at constitutive levels in highly susceptible (LSS) and resistant (LSR) sugarbeet lines. Using a fluorometric chitinase assay we have found significantly higher levels of chitinase in leaf spot resistant lines *vs.* the susceptible lines (Figs. 3 and 4). The activity was detected by fluorometry by measurement of release of the fluorescent hydrolysis product of 4-methylumbelliferone per mg protein per hour from the substrate 4-umbelliferone-β-D-N,N'-diacetyl-chitobioside. In the figures, MU = 4-methylumbelliferone, 3 = boiled LSS enzyme extract + substrate, 4 = boiled LSR enzyme extract + substrate, 5 = no enzyme extract + substrate, 6 = no substrate + LSS extract, and 7 = no substrate + LSR extract. We are comparing other chitinase assays and products to determine if this is indeed endochitinase or exochitinase activity in the plant. Purification of the chitinase was accomplished using differential centrifugation, ammonium sulfate precipitation, and chitin affinity purification. Fractions were separated by a 12% linear SDS-polyacrylamide gel electrophoresis detected enrichment at 34 Kda. The implications and possible role of chitinase in *Cercospora* resistance is still subject to speculation. We believe that it may be a part of the total resistance mechanism.

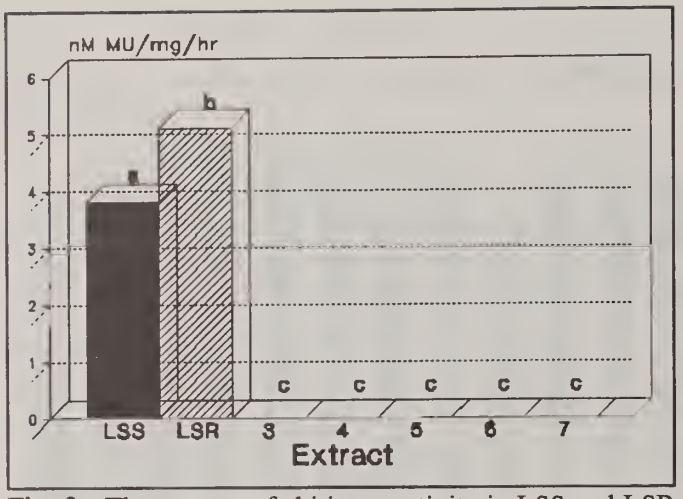

Fig. 3. The amount of chitinase activity in LSS and LSR 6-week-old sugarbeet leaves. Bars with the same letters are not significant using Duncan's multiple range test (P=0.05).

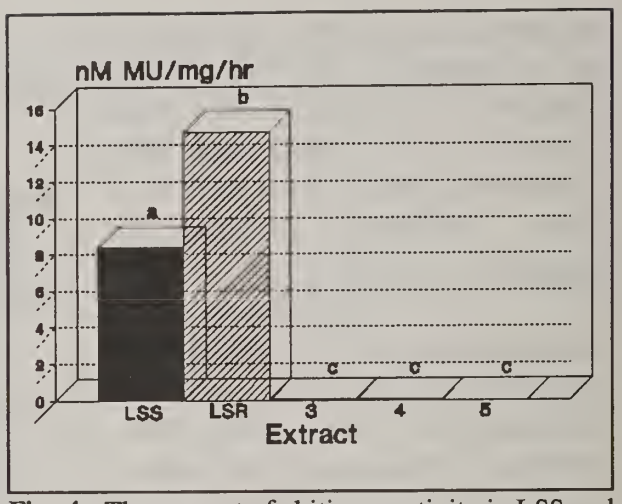

Fig. 4. The amount of chitinase activity in LSS and LSR 9-week-old sugarbeet leaves.

SUGARBEET ROOT MAGGOT SUSCEPTIBILITY TO ENTOMOPATHOGENIC NEMATODES

C. A. Wozniak, G. A. Smith and L. G. Campbell

Nematodes known to specifically infect and reproduce within insects have become a commercially available, economically attractive alternative to traditional control measures for several insects affecting both crops and animals. Many groups of nematodes have been recorded to infect a variety of insect orders, but the two principal nematode families that have emerged with the greatest application potential are the Steinernematidae and the Heterorhabditidae. These two groups have been the focus of much of our recent research into the feasibility of using entomopathogenic nematodes for biological control of the sugarbeet root maggot (SBRM).

Species of both families rely on a symbiotic member of the bacterial genus *Xenorhabdus* for their successful reproduction. Following ingress into the insect through a natural opening, these symbionts are released from the nematode digestive tract into the haemocoel of the host. The rapid multiplication of this bacterium creates a fatal septicemia and provides a nutrient rich environment for the nematode to reproduce within. The species and strain phenotype of the symbionts vary with the nematode strain/species they are associated with, but all symbionts have evolved to provide their host nematode with everything needed to reproduce prolifically within the insect cadaver.

In Vitro Evaluation.--Third instar SBRM were placed in sterile coarse sand containing 270 nematodes per dish. This approximates a field rate of 3 billion infective juvenile (IJ) nematodes per acre; recommended field rates vary from less than 1 billion to 3 billion IJ per acre depending on the cropping system and target pest. Following a three-day incubation at 24 C in the dark, SBRM were washed and transferred to plaster mounts for observation.

Six strains of *Steinernema* representing three species, and four strains of H*eterorhabditis bacteriophora*, have been tested in this manner to date. All were capable of infection and reproduction within third instar SBRM; however, rates of infection were generally low (1 to 9%). Mortality of larvae was significantly higher than controls for some strains when measured 21 days after coincubation. Early evidence of nematode infection was noted in some larvae but ultimately did not lead to nematode reproduction and egress from the cadaver. We speculate that variance in endogenous microflora of the SBRM may preclude successful establishment of the *Xenorhabdus*-induced septicemia and, hence, reduce or eliminate nematode reproduction under these conditions. *This infection of SBRM represents the first report of entomopathogenic nematodes infecting any member of this family (Diptera:Otitidae).* Despite the low overall infectivity rate *in vitro*, we are encouraged to evaluate these agents in the field. *In vitro* assays rely on brief coincubation of nematodes and insects in a substrate that is foreign to conditions involved in field culture.

Four strains of *Heterorhabditis bacteriophora* have been evaluated in the laboratory under conditions as described above. These strains were raised in our lab in *Galleria mellonella*, the greater wax moth, larvae. Due to the additional work involved in rearing and maintenance of these strains, fewer experiments have been performed with them compared to the steinernematids. Preliminary results show a similar overall response in terms of susceptibility, however. Each of the four strains was capable of infecting and reproducing prolifically within SBRM third instars, albeit at a low total percentage of infection rate.

Adult SBRM fly infection was evaluated with the same six strains of *Steinernema spp.*, and all were found capable of infection and reproduction. Coincubation of flies overnight (at 24 C in glass dishes with 0.85% saline saturated filter paper containing a 3 billion per acre rate of IJ) resulted in 80-100% infection. Egress of nematodes was at five to seven days post-coincubation compared with 14 to 21 days for larval SBRM. *S. glaseri* was evaluated further in time course experiments and found to be capable of infecting adults with the shortest coincubation time tested (*i.e.*, two hours). Flies were typically killed within six to 24 hours after infection. We will be testing fly traps baited with sucrose and nematodes this season to determine the potential for reduction in adult population numbers through this infection route. The infection of adult Dipterans with entomopathogenic nematodes has only recently been reported, and this is the *first observation of adult susceptibility in this family.*

Field Trials.--The six strains of *Steinernema* tested *in vitro* were evaluated under typical field conditions (near Hillsboro, North Dakota) during the 1992 season to test their ability to infect in soil. Two or four applications of nematodes per season were evaluated for each strain. Nematodes were suspended in normal saline and applied through hand sprayers into trenches cut alongside the two center rows of a four-row plot. A randomized complete block design with four replicate blocks was used. Plants from four feet of each of two rows were harvested in August for root damage ratings. SBRM were collected from these portions of the plots and again just prior to harvest from the remaining 21 feet of rows in late September.

Infected SBRM larvae were recovered from all nematode treatments but not from control plots or outside the plot area. Enumeration of infected individuals as a percent of total larvae was difficult in that the heavy clay soil skewed the data towards collection of healthy individuals. Infected SBRM turn brown and soft with destruction of the cadaver soon after reproduction of

nematodes. Sampling within a short time after application may be required to determine these data; however, the destructive sampling required will preclude yield data from the same plot area.

Due to the unusually cool, rainy conditions and early strong growth of plants, significant damage to roots was less than expected based on the high levels of larvae observed. Previous season's yield for this plot was approximately six tons per acre in 1991; our controls and treatments were not significantly different from each other and averaged 15 to 17 tons per acre. Sucrose yield, purity, and root damage ratings were also similar between treatments.

Sampling of soil for nematode survival by trapping with wax worm larvae indicated survival of all strains at least two months after the last application in July. The plot was left untilled and marked in the fall so that we may repeat sampling to check for overwintering capabilities of these strains when spring arrives. Larvae will be collected in April and May as they move toward the surface to determine if remaining nematodes can infect diapaused third instars prior to pupation.

BSDF PROJECT 610

UTILIZING RESISTANCE MECHANISMS FOR *RHIZOCTONIA SOLANI*

W. M. Bugbee

Plants often respond to disease by the synthesis of compounds toxic to the invading microorganisms. These antibiotics are called phytoalexins. Sugarbeets produce two phytoalexins when infected by the foliar pathogen *Cercospora beticola*. The level of production of one of these phytoalexins is associated with resistance. In response to infection by *Rhizoctonia solani*, three phytoalexins have been reported, but their relation to resistance has not been examined. The induction of phytoalexins is being investigated here to assess their role in the biochemical mechanism of resistance to *R. solani* and a possible association with a pectin lyase inhibitor protein which we previously described. Research elsewhere has shown that an inhibitor of a pectolytic enzyme enhanced the plant's synthesis of phytoalexins.

Phytoalexins and Age-associated Root Rot Resistance.--Sugarbeet seedlings are susceptible to *R. solani* but become resistant as they age. Of the several anastomosis groups of *R. solani* that are recognized, members of AG 2-2 are associated with root rot of plants of all ages, and AG 4 is associated only with seedling disease. Seedlings of the cultivar Ultramono were susceptible to AG 2-2 and AG 4. Four weeks after planting, plants were highly resistant to AG 4 and still susceptible to AG 2-2. Root rot resistant (FC 712) and susceptible (Ultramono) plants were inoculated with AG 2-2 or AG 4 at three or five weeks after planting. The diseased tissues from both cultivar's roots were extracted to recover phytoalexins. The extracts were assayed by measuring the inhibition of the linear growth of AG 4 on extract-amended agar. The results in Table 1 show phytoalexin activity was present in five-week-old but not three-week-old plants. Infection by AG 4 induced more phytoalexin activity than AG 2-2 in FC 712. The antibiotic activity in inoculated disk extracts of Ultramono did not differ from the uninoculated

Table 1. Growth response of *Rhizoctonia solani* AG 4 to root extracts of FC 712 and Ultramono after infection with AG 2-2 or AG 4 at 3 or 5 weeks after planting.

	Cultivar			
	FC 712		Ultramono	
	Age at inoculation (wk)			
Inoculum	3	5	3	5
	%<[a]	%<	%<	%<
AG 2-2	0	41a	0	22c
AG 4	0	35b	0	19c
None	0	24c	0	22c

[a]%< = reduction in linear growth of the fungus on potato dextrose agar amended with tissue extract as a percentage of unamended control. Means not followed by the same letter within a column are not significantly different according to Duncan's multiple range test (P=0.05).

controls, indicating that phytoalexins were not induced in Ultramono. Both hosts had antibiotic activity in extracts of uninoculated roots. Evidently, toxic metabolites were produced and present in the five-week-old plants.

In a second experiment, the amount of root rot was measured in addition to phytoalexin formation. The root rot measurements in Table 2 show that Ultramono was more susceptible than FC 712 to AG 2-2. Both FC 712 and Ultramono were more resistant at five than at three weeks after planting, and both were more resistant to AG 4 than AG 2-2. The response of AG 4 to tissue extracts showed that the older FC 712 plants produced more phytoalexin than the younger plants and that age had no effect on phytoalexin production by Ultramono. Again, the uninoculated FC 712 had as much preformed antibiotic as the inoculated plants, demonstrating that infection did not stimulate synthesis of phytoalexin. There were higher levels of phytoalexin in infected than in uninoculated Ultramono.

In this test, the phytoalexin levels in these two genotypes did not strongly support the hypothesis that phytoalexin is involved in resistance. The data does indicate, however, that AG 4 is less virulent than AG 2-2 because (1) it induced more phytoalexin than AG 2-2 and, (2) it is more sensitive to the phytoalexin than AG 2-2.

Pectin Fragments as Elicitors of Phytoalexins.--When the plant receives signals to produce phytoalexins as a defence response, the signals come from such sources as fragments of its own cell walls or cell walls of invading pathogens. Pectic fragments of sugarbeet root cell walls were tested here for their ability to elicit phytoalexins. Pectin was purified from cell walls of resistant FC 712 and susceptible Ultramono and used as the sole carbon source in broth cultures of AG

Table 2. The effect of age on the susceptibility of root rot resistant FC 712 and susceptible Ultramono and the induction of phytoalexins after infection with AG 2-2 or AG 4 of *Rhizoctonia solani*.

Cultivar germplasm	Inoculum	Rot % (w/w)		% Growth decrease of AG 4	
		Age (wk)			
		3	5	3	5
		%	%	%<	%<
FC 712	AG 2-2	18	2	2b	28a
FC 712	AG 4	7	0	11b	29a
FC 712	None	0	0	9a	19ab
Ultramono	AG 2-2	72	38	26a	27a
Ultramono	AG 4	3	0	32a	19ab
Ultramono	None	0	0	10b	12b

Means followed by the same letter within a column are not significantly different according to Duncan's multiple range test (P=0.05).

2-2 and AG 4. Samples of broth in which the fungus was cultured were heat-killed, dialyzed, concentrated, and then applied to root disks. The dialyzed broth containing large molecules, presumably pectin fragments, did elicit phytoalexins because extracts of treated root disks inhibited growth of the fungus. Broth containing pectin from Ultramono elicited more phytoalexin than broth containing pectin from FC 712 ($F = 8.5^{**}$). Broth in which AG 2-2 grew elicited more phytoalexin than AG 4 broth, although neither isolate elicited more than uninoculated broth ($F = 6.03^{**}$). The inhibitory quality of extracts of root disks that were amended with uninoculated broth suggests that phytoalexins were produced by the disks in response to wounding and/or that a significant level of antibiotic was preformed in the root tissue. These results also confirmed that AG 4 is more sensitive than AG 2-2 to phytoalexin ($F = 8.04^{**}$).

Thin Layer Chromatography of Phytoalexins.--Root tissue infected with *R. solani* was extracted in ethanol. The ethanol extract was partitioned with a phosphate buffer and ethyl acetate. The acetate fraction was evaporated to dryness and redissolved in ethanol. The ethanol fraction was spotted on silica gel plates and developed in hexane:ethyl acetate:methanol (55:40:5). Under far UV light, one faint and three distinct spots were evident. Overlays of a mycelial suspension of *R. solani* on the air-dried plate showed that these fluorescent spots were antibiotic. These results confirm an earlier Japanese report of three flavonoid phytoalexins being produced in response to *R. solani* and also show a fourth, faint spot.

Effect of Sugars on Pectolytic Enzyme Production.--Sugars have long been known to suppress the production of pectolytic enzymes by fungi. The purpose of this study was to measure the effect of sugars on PNL and exoPG production by isolates of AG 2-2 and AG 4 and to test the

hypothesis that the higher sugar content of sugarbeet roots affects the virulence of *R. solani*. Four isolates of diverse origin for each of AG 2-2 and AG 4 were grown in broth culture containing sugar-free root cell walls as the carbon source. The broth was amended by aseptically adding sterile glucose, fructose, or sucrose to give 1.5% (w/v). Broth samples were collected after six days incubation and assayed for PNL and exoPG activity. The analysis of variance showed a nonsignificant effect of sugars on PNL production by the isolates of AG 2-2 and no interaction of sugars X isolates; however, sugars suppressed the production of exoPG. The isolates of AG 4 showed a significant response to sugars with a sugars X isolates interaction. All three sugars suppressed PNL and exoPG production by AG 4. Sucrose and fructose were more effective than glucose in suppressing exoPG production by isolates of AG 2-2.

This test must be repeated for confirmation, but the initial results suggest that AG 4 is less virulent than AG 2-2 on older plants partly because the disease-related pectolytic enzymes are suppressed by sugars at a concentration that you would expect to find in plants beyond the seedling stage and in roots.

Using ELISA to Select Root Rot Resistant Plants.--Sugarbeets synthesize a pectin lyase inhibitor protein (PNLIP) that appears to play a part in resistance by inhibiting the activity of an important cell wall degrading enzyme (pectin lyase) of *R. solani*. An enzyme-linked immunosorbent assay (ELISA) method has been developed that measures the amount of PNLIP in very small samples of plant extract. ELISA has been used to select 21 high PNLIP plants out of +800 that were assayed. These 21 selections are in photothermal induction and are due to come out in May. Clones will be produced from axillary buds and evaluated for resistance to *R. solani*, perhaps by the end of this year.

BSDF PROJECT 630

PRE-BREEDING

D. L. Doney

The historical development of sugarbeet suggests a narrow genetic background from which current commercial hybrids are developed. Wild *Beta* germplasm constitutes the major gene source for sugarbeet germplasm enhancement. Of the wild species, the subspecies *B. maritima* offers the most promising source for genetic enhancement. This subspecies is the most widely distributed, exhibits an enormous amount of genetic variation, and crosses readily with sugarbeet. Centuries of natural selection under severe stress conditions has resulted in the accumulation of many stress resistant genes for both disease resistance and growth. Because of the long-term commitment needed to effectively broaden the genetic variation in sugarbeet breeding pools, few attempts have been made to incorporate wild germplasm.

The major objective of this research is to develop new near-sugarbeet type populations from crosses between wild relatives and sugarbeet. These near-sugarbeet type populations should have new or different growth genes from those in current sugarbeet breeding pools and, therefore,

should add additional genetic variation for growth and vigor. Near-sugarbeet type populations can be integrated into elite sugarbeet breeding pools for future utilization.

Near-sugarbeet Selections.--In 1986, seven *B. maritima* accessions were crossed to the same sugarbeet male sterile line (L53cms). After one intercross to allow for recombination, each segregating population was selected for root shape in four successive cycles. For each cycle, selected roots of each cross were inter-pollinated in separate isolation chambers. Several of the populations approached sugarbeet in root shape after four selection cycles. The resulting populations were tested in field trials in 1991.

Based on the 1991 field data, the most promising populations were tested in replicated field trials in 1992 (Table 1). The trials consisted of three near-sugarbeet populations (x115, x116, and x111) and two commercial sugarbeet hybrid checks. These selections responded relatively well considering selection pressure was only for root shape. The selected populations approached the commercial hybrids in root yield and sucrose concentration. They were poorer in quality (i.e., higher in sodium, amino nitrogen, and sugar loss to molasses) but equal in potassium. Of these three populations, the x115 and x116 selections were the best in quality and sucrose concentration.

Table 1. Yield, sucrose, and non-sucrose quality factors and loss to molasses (SL) for three near-sugarbeet type populations (selected from sugarbeet x *B. maritima* crosses).

Entry	Root Yield T/A	Sucrose %	Na ppm	K ppm	Amino N ppm	SL LBS	Tare %
x111	17.5	10.1	1449	1951	1118	2.8	1.7
x115	17.1	12.3	1073	1833	1033	2.5	1.5
x116	16.3	12.3	1022	1806	1080	2.5	1.7
Monohikari	20.3	13.9	894	1808	865	2.2	1.2
Beta 2010	20.3	14.4	789	1987	857	2.2	1.0
LSD P = 0.05	3.0	0.6	165	149	96	0.2	1.1

In addition to the above field trial, seed of each sib (individual seed plant) of each selection was planted in a four-row observation plot. Plots were scored for canopy type, vigor, root shape, multi-crown, and root specific gravity. Thirty-five sibs in population x115 and 12 sibs in population x116 were selected for continued selection efforts. Roots from each of the selected sibs were vernalized for crossing to sugarbeet male sterile lines and seed multiplication. Combining ability analyses will be conducted in these crosses for early growth, vigor, and productivity.

New Populations.--Several new populations are being developed. Regional mixtures of *B. maritima* or other subspecies of *B. vulgaris* were crossed to a sugarbeet line segregating for genetic male sterility. All populations have been advanced to the sib 3 seed stage. Seed was harvested only from the male sterile plants at both the sib 2 and sib 3 stages to insure continued crossing and recombination to occur.

Three characteristics of wild *Beta* germplasm that have discouraged its utilization in sugarbeet breeding are: 1) slow germination, 2) slow leaf initiation, and 3) annual growth habit. The annual growth habit is selected against in each cycle by simply eliminating bolting plants. If selection is practiced without attention to slow germination and slow leaf initiation, advanced populations may continue to carry these two undesirable characteristics.

We have found these characteristics to be highly heritable. Germination and leaf initiation have been significantly improved by employing growth chamber selection methods. Seedling selection for early germination and leaf initiation will be conducted in these populations for one to two cycles prior to field selection studies.

Stress Selection.--Stress selection is a growth chamber approach designed to identify genotypes in the seedling stage that store sucrose in the early stages of growth. Small positive increases in both sucrose concentration and root yield from one cycle of stress selection were observed in earlier studies.

Stress selection has now been conducted in three diverse populations for four and five selection cycles. The resulting populations were tested in replicated field trials in 1991 and 1992. The results of the two years of testing are presented in Tables 2, 3, and 4.

Table 2. Field performance of stress selection populations after four successive cycles of stress selection in population r22.

	Root Yield T/A		Sucrose %		Total Sugar Yield LBS/A	
Entry	1991	1992	1991	1992	1991	1992
r22s1**	13.9b*	17.6b	13.4a	11.7a	3724b	4105b
r22s2	16.2a	19.5ab	13.7a	12.0a	4437a	4660ab
r22s3	16.2a	20.5a	13.6a	12.1a	4390a	4971a
r22s4	16.1a	20.7a	14.2a	12.0a	4572a	4974a

* Means followed by the same letter are not significantly different at P = 0.05.
** Numbers 1-4 indicate selection cycle number.

There was no year by entry interaction in any of the three populations. Yields were higher and sucrose concentration lower in 1992; however, both years gave the same trends. A significant increase in root yield was obtained in the second cycle for each population; however, subsequent selection cycles resulted in no apparent change. A small non-significant decrease in root yield occurred in the fourth cycle of the 3747 population (Table 4). This population was the least heterozygous of the three, and the slight reduction may reflect inbreeding depression. Sucrose concentration was unaffected by stress selection.

Table 3. Field performance of stress selection populations after stress selection cycles two through five in population r528.

Entry	Root Yield T/A 1991	Root Yield T/A 1992	Sucrose % 1991	Sucrose % 1992	Total Sugar Yield LBS/A 1991	Total Sugar Yield LBS/A 1992
r528s2**	9.2b*	17.8b	11.7b	9.9b	2145b	3487c
r528s3	15.2a	23.5a	12.3a	9.2b	3754a	4280bc
r528s4	13.6a	22.6a	12.7a	9.9b	3427a	4479bc
r528s5	15.1a	25.5a	2.3a	11.2a	3692a	5698a

* Means followed by the same letter are not significantly different at P = 0.05.
** Numbers 2-5 indicate selection cycle number; the first cycle was not tested due to insufficient seed.

Table 4. Field performance of stress selection populations after four successive cycles of stress selection in population 3747.

Entry	Root Yield T/A 1991	Root Yield T/A 1992	Sucrose % 1991	Sucrose % 1992	Total Sugar Yield LBS/A 1991	Total Sugar Yield LBS/A 1992
3747s1**	13.1b*	18.4b	13.8a	11.9a	3606b	4380b
3747s2	16.4a	21.7a	13.8a	11.8a	4524a	5124ab
3747s3	16.9a	21.7a	13.6a	12.0a	4597a	5202a
3747s4	14.2ab	20.3ab	13.8a	11.9a	3910ab	4838ab

* Means followed by the same letter are not significantly different at P = 0.05.
** Numbers 1-4 indicate selection cycle number.

These were very divergent populations with differences in amount of heterozygosity. Since all three populations behaved similarly to stress selection (i.e., an increase in root yield the first cycle followed by a leveling off and no effect on sucrose concentration), these results suggest that most of the additive genes for root yield were fixed in the first cycle of selection.

Root yield is reported to be conditioned by both additive and non-additive genes. The selection scheme utilized herein capitalized only on additive genes. This procedure should be evaluated for its effect on non-additive yield genes. Studies to evaluate these effects are in the planning stages.

Green Leaf Duration.--Increases in production have been achieved in many crops by altering the harvest index (i.e., partitioning the total photosynthate in favor of the economically harvestable partition). In cereal crops, economic gains have been achieved by genetically shortening the straw while increasing the head size. In sugarbeet, the harvest index can be improved by increasing the root/shoot ratio (i.e., partitioning more of the photosynthate to the root and less

to the leaves). It is generally known that beets produce more top than is needed for photosynthesis after the full canopy is reached. In addition, old leaves are dying and new leaves are continually being produced throughout the growing season. If the photosynthetic activity of the leaves could be extended, fewer leaves would be needed and more photosynthate might be translocated to the root.

Last year we reported on efforts to genetically alter the green leaf duration of the first leaf. Three cycles of divergent selection for green leaf duration increased duration of the first leaf to seven days under controlled growth chamber conditions. Populations resulting from the first two cycles of divergent selection for green leaf duration and the parent population were grown in multi-harvest replicated field trials. Plants were harvested every three weeks, and data were taken for senescent leaves, total leaves, leaf size, top dry weight, and root dry weight.

The effects of altering the green leaf duration of the first leaf on leaf senescence throughout the growing season is presented in Table 5. Senescent leaf numbers per plant for the early senescing populations (V763E and W250E-E) tended to be higher than the parent population (WC5), whereas the late senescing populations (V762L and W249L-L) had fewer senescent leaves than the parent. These trends were apparent throughout the growing season, and on the final harvest the early senescent populations produced significantly more and the late senescent populations produced significantly less total senescent leaves than the parent (Table 5).

Table 5. Mean number of senescent leaves per plant for populations selected for early and late green leaf duration at the June 12, July 24, August 14, September 4, and September 25 harvests.

	Harvest Dates				
Population	June 12	July 24	Aug. 14	Sept. 4	Sept. 25
W249L-Late	2.2c*	3.7d	5.7c	12.2c	19.8c
V762Late	2.4bc	4.0d	6.3c	15.0b	22.9c
V763Early	2.8ab	5.0a	8.3a	18.0a	32.7a
W250E-Early	2.7abc	4.8ab	7.8a	17.0ab	29.8ab
Parent (WC5)	2.7abc	4.6bc	7.2b	16.6ab	27.5b

* Means followed by the same letters are not significantly different at P = 0.05.

Canopy leaf number and leaf size were also affected by divergent selection for green leaf duration of the first leaf. The early senescing populations produced more and smaller leaves than the late senescing populations (Table 6). The increased number of leaves was offset by smaller leaf size and resulted in no difference in total leaf area.

Table 6. Mean leaf number, leaf size, and total leaf area (canopy) for the parent and early and late senescing populations.

Population	Leaf Number (per plot)	Leaf Size/leaf (sq cm)	Total Leaf Area (sq cm/plot)
Late Senescing	1064b*	204a	217,184a
Early Senescing	1231a	168b	206,601a
Parent (WC5)	1000b	177b	194,975a

* Means followed by the same letter are not significantly different at p = 0.05.

Recurrent mass selection in population WC5 for extended green leaf duration did not affect root and canopy dry matter accumulation, but selection for decreased leaf duration had a detrimental effect on root dry matter accumulation (Table 7). Differences in total plant dry matter can be attributed to differences in root dry matter. The reduced root dry matter observed in the early senescing selections may be a result of inbreeding depression, since the first selection cycle consisted of a relatively small number of plants.

Table 7. Mean root, canopy, and total dry matter (canopy plus root) over harvest dates.

	Dry Matter		
Population	Root	Canopy (g per Plot)	Total
W249L-Late	1182a*	900a	2082a
V762Late	1118a	994a	2112a
V763Early	959b	817a	1776b
W250E-Early	829c	851a	1680b
Parent (WC5)	1206a	812a	2018a

* Means followed by the same letters are not significantly different at P = 0.05.

Selection for green leaf duration was conducted in two additional broad base populations. The resulting populations will be tested in replicated field trials to evaluate the effects of green leaf duration on root yield and sucrose concentration.

Leaf Initiation.--Last year we reported on studies designed to genetically alter time of leaf initiation. It was demonstrated in growth chamber tests that leaf initiation can be genetically changed by appropriate selection. It seems logical to assume that the earlier the plant initiates leaves the faster it grows. If this characteristic is coupled with green leaf duration, the ideal plant would have early leaf initiation followed by late leaf senescence. It has been observed that productive commercial hybrids have these characteristics.

Attempts were made to identify and select for genotypes with all combinations of leaf initiation and leaf senescence (early and late). Combining early leaf initiation with late senescence was difficult; however, selections with sufficient seed to field test were obtained in only two populations. The results of these tests are given in Table 8.

Table 8. Mean sugar percentage, root yield, and sugar yield for combinations of (early and late) leaf initiation and green leaf duration selections.

Entry	Leaf Initiation	Leaf Duration	Sugar %	Root Yield T/A	Sugar Yield LBS/A
i32 (Parent)			11.2a*	20.8a	4678a
x117	Early	Early	11.3a	18.9a	4267a
x118	Late	Early	11.3a	20.0a	4536a
x123	Early	Late	11.4a	18.5a	4230a
x124	Late	Late	11.2a	17.1a	3843a
Parent not available					
y172	Early	Late	11.8a	17.2a	4059a
y171	Early	Early	12.0a	16.7a	4070a
y170	Late	Late	11.7a	16.1a	3758a

* Means followed by the same letter are not significantly different at p = 0.05.

There were no differences among the selection combinations for sugar concentration, root yield, or sugar yield. This data suggests that leaf initiation has no effect on root yield and sucrose concentration. However, the difficulty in obtaining the selection combinations suggests low heritability for the different combinations and may have resulted in environmental selections rather than genetic selections.

Beta Germplasm.--Beta germplasm activities this past year included seed multiplication, germplasm evaluation, and germplasm collection.

One hundred accessions were increased under controlled isolation conditions at Logan, Utah. Poor germination in some types has caused much concern in regard to maintaining sufficient genetic variation in new increases. Several options to the present system were pursued in an effort to obtain a better representation of the existing genetic variation in seed increases. One option (germinating in the greenhouse and transplanting to the field) was very successful. However, the cost, time, and greenhouse space needed may be too expensive and time consuming. Another option investigated was to move the seed increase program to Pullman, Washington. This location is a USDA plant introduction station similar to the Ames, Iowa station. The environmental conditions necessary for good seed production are superior to the Ames location. In order to test the potential of the location, pilot plots were planted for over wintering at Pullman, Washington.

Sixty accessions were evaluated for disease resistance and several other important characteristics. Most of the accessions evaluated this past year were of the subspecies *B. maritima*. Annuals in

some of these accessions make evaluation very difficult and less accurate. This is an ongoing program, and additional accessions will be evaluated next year.

A collection expedition was conducted to the Nile River Delta and Nile River regions for wild *B. maritima* germplasm. This subspecies was found throughout the Delta area. The network of canals and ditches in this area serves as an effective agent in the distribution of *B. maritima* seed. Wild *B. maritima* germplasm was found in the Upper Nile valley, largely because local farmers have been growing it as a green leafy vegetable. Seed of the collections have been deposited in the Ames, Iowa collection for preservation. Seed increases will be made this coming year in order to facilitate the evaluation of the germplasm.

BSDF PROJECT 631

WORLD *BETA* NETWORK

D. L. Doney

The World *Beta* Network (WBN) was founded in 1989 with the objective of providing a forum for international involvement in *Beta* germplasm resources. Representatives from most sugarbeet producing countries have been actively involved in past activities. These activities include germplasm preservation, documentation, evaluation, and utilization. Since *Beta* germplasm is important to many countries, an international effort is essential for the preservation, evaluation, and utilization of this valuable germplasm.

The third biennial conference of the WBN will be held August 4-6, 1993 in Fargo, North Dakota. The major focus of the 1993 conference will be on pre-breeding and gene transfer. The theory and practical application of pre-breeding will be discussed by eight prominent speakers. One session will include international experts in gene transfer and RFLP research. The working sessions will deal with reports on and the planning of collection expeditions, seed regeneration, data exchange, and germplasm evaluation. The results and recommendations of the meeting will be published. All interested parties are invited.

BSDF PROJECT 641

ASSESSMENT OF ENDEMIC SYMBIOTIC BACTERIA FOR BIOCONTROL OF SUGARBEET INSECT PESTS

C. A. Wozniak

Various species of bacteria are inhabitants of insect eggs, larvae and adults; these may have a negative (*i.e.*, pathogenic) or positive (*i.e.*, symbiotic) impact on the insect's development. Similarly, bacteria associated with the rhizosphere and internal tissues of the host plant can have varying influences on growth of the host. The goal of this study was to identify the microbial flora associated with the maggot:sugarbeet interaction and ascertain the role they might play in maggot development.

Third instar sugarbeet root maggot (SBRM) larvae were sampled from the following areas: Sidney, Montana - Williston, North Dakota; Powell - Ralston, Wyoming; Bayard - Scottsbluff, Nebraska; and Sabin, Minnesota - Fargo, North Dakota. Larvae were washed with Triton X-100/Tween-20 (0.1% v/v), incubated in 0.2% hypochlorite for four minutes, washed three times with sterile phosphate buffered saline (PBS), and homogenized in sterile PBS. The homogenates were plated in dilution series onto LBS5 (rich growth medium), CT (semi-selective for Serratia spp.), XSNC (selective for *Flavobacterium spp.* and *Xanthomonas maltophilia*) and XSNCI (selective for *X. maltophilia*). Plates were incubated at 30 C. Counts were taken from one through five days and all colonies of varying coloration or morphology subcultured to the same medium for regrowth. Three subsequent subcultures ensured purity of these insect-endogenous bacteria (IEB) isolates prior to freezing in TSS solution at -80 and -20 C.

Rhizospheric and endophytic bacterial root isolates were obtained from field-grown plants raised under screened mesh cages in soil known to be uninfested with the SBRM. Sticky stakes were placed within cages to assess ingress of insects, and roots were observed to be free of insects or damage. Roots were sampled at early, mid, and late season by removing soil with sterile forceps and immersing the lower 4/5 of the root in sterile PBS. After 15 minutes of stirring/agitation, the PBS was plated in serial dilution onto the media described above. Roots were then subjected to a 10-minute incubation in 0.5% hypochlorite with 0.1% Tween-20. Internal tissue pieces (approximately 5-mm discs) were taken from the upper, middle, and lower portions of the root with a sterile scalpel; these were plated directly onto the same media used above. Following incubation at 28 C for one to seven days, colonies were enumerated from the root washes (rhizospherics), and bacteria from all samplings were subcultured to identical media. After three subcultures indicated uniform growth, these isolates were frozen for storage as above.

Gram stains were performed on all isolates after 20 to 24 hours growth in LBS5 broth. Isolates were grown on tryptic soy agar prior to identification using the Biolog 3N database.

Gnotobiotic SBRM eggs were produced by surface disinfestation and allowed to hatch on Murashige and Skoog plant tissue culture medium supplemented with 3% (w/v) sucrose (MS). Axenic cell cultures of clone 'REL-1' and line 'EL48' were added to these MS plates (in separate experiments) to determine the ability of the SBRM larvae to develop (*i.e.*, moult) in the

absence of bacteria. Root cultures from aseptically germinated 'H5135' and 'MONOHI' and hairy root cultures from *Agrobacterium rhizogenes*-mediated transformation of 'H5135' and 'REL-1' hypocotyl explants were similarly cultured in MS medium with gnotobiotic SBRM larvae.

RESULTS

Sugarbeet Root Maggot Associated Microflora.--The overwhelming majority of IEB isolates from all samples were gram negative and grew well on standard rich growth media (*i.e.*, Luria-Bertani, Tryptic Soy). Approximately 2000 isolates were recovered for storage, with just under 500 identified to date. Fifteen or 16 different species of IEB were identified from third instars from each geographic region, with significant overlap in identity between profiles. Of these bacteria, the only species to be represented in SBRM from all geographic samplings was *X. maltophilia* (Xm). Various species of *Serratia* and *Flavobacterium* were also commonly encountered but were absent from one or more geographic samplings of larvae. *S. liquefaciens* and *S. marcescens*, previously reported with all stages of SBRM, were encountered rarely or not at all outside the Red River Valley.

Sugarbeet Associated Microflora.--Rhizospheric samplings identified 29 species of bacteria associated with the rhizoplane. *X. maltophilia*, *Pseudomonas spp.*, and *Enterobacter spp*. were the most commonly encountered isolates from these samples. Internal tissue sampling identified predominantly *Flavobacterium gleum*, with *Pseudomonas spp.*, *Serratia liquefaciens*, and *X. maltophilia* in occasional samples. In general, all species present endophytically were also present on the rhizoplane; however, only a small subset of the rhizoplane bacteria were found internally. The total number of species as well as their relative frequency in samples will undoubtedly change as more of the isolates are identified.

In Vitro Rearing.--When evaluated on tissue cultures of roots and hairy roots, all larvae failed to moult, although feeding on root surfaces was observed. Larvae survived as long as 55 days after hatching but failed to increase significantly in size and eventually died. In experiments using cell cultures, 8% of larvae were observed to moult to the second instar stage but without further development. The addition of either of two isolates of Xm (from SBRM sampling) to axenic cell cultures in normal saline at the onset of the coculture did provide for an increase in moulting (35%), and several third instars were obtained. Some of these third instars were subcultured to fresh plates with cells in an attempt to allow further growth and eventually cold storage to complete the mandatory diapause period.

Two isolates of Xm, one from SBRM eggs and one from third instar larvae, were both capable of enhancing moulting of first instar SBRM *in vitro* when coincubated with suspension cells. An unidentified endophytic bacterium arising from the sugarbeet cell culture also demonstrated the ability to provide for development of first instar larvae when coincubated with 'REL-1'. Further evaluation of these isolates as well as other bacterial species will be performed to determine how widespread this capacity is among IEB. Analysis of Xm culture filtrate fractions will be tested in an attempt to identify the factor(s) responsible for successful SBRM development. Coincubation of first instar SBRM and Xm on MS without sugarbeet cells did not provide for moulting of larvae.

Xm was chosen for initial testing *in vitro* based on its ubiquity in all SBRM and sugarbeet tissue samples. Analysis of Xm isolates from various regions and environments by SDS-PAGE of outer membrane proteins has revealed differences among groups. The taxonomic status of Xm is nebulous, with the erection of a new genus for this species likely in the near future. Our ability to characterize these strains will eventually aid in obtaining regulatory permits necessary to test genetically engineered forms of this bacterium as a seed inoculant.

BSDF PROJECT 642

ISOLATION AND CHARACTERIZATION OF *BACILLUS THURINGIENSIS* FOR BIOCONTROL OF SUGARBEET INSECT PESTS

C. A. Wozniak and Sarah E. Hinz

A variety of insect species representing several orders and many non-arthropod phyla have been included among those organisms with known susceptibility to *Bacillus thuringiensis* (Bt). Environmental sampling has produced a plethora of new isolates of Bt in the past five years, many of which have been characterized with respect to insect host range. To date, no screening of Bt isolates for activity against the sugarbeet root maggot (SBRM) or most other insect pests of sugarbeet has been performed. The two primary goals of this project were (1) to isolate, characterize, and screen new Bt strains, and (2) to clone the responsible *cry* or *cyt* gene from Bt to a suitable rhizospheric bacterial vector.

Isolation of Novel Strains of Bt.--The published methods of Sateh *et al.* and Travers *et al.* were modified and combined to allow for efficient isolation of Bt from various environmental samples. Soil, insects, plant debris, and plant roots were homogenized and suspended in 0.85% saline and centrifuged to remove debris. The supernatants from these extractions were made 0.25 M with respect to sodium acetate and incubated overnight at 30 C, 200 rpm. This allows for growth of most microbes present but precludes germination of Bt endospores. Cultures were then heated to 80 C for 10 minutes and plated onto Bt medium with ampicillin at 100 μg/ml and Polymyxin B at 40 μg/ml. After incubation for 24 to 48 hours, colonies resembling *Bacillus spp.* were subcultured to Bt/Amp/PolB for isolation. Isolates were gram stained, stained with Malachite green/Safranin O to check for crystal/spore production, and analyzed on the Biolog 3N database for species identification.

Analysis of Bt Strains.--A subset of the isolates obtained was sporulated in Bt broth, centrifuged, washed in distilled water, and separated on NaBr density gradients. The original sporulated culture and the fractions from the density gradients were analyzed by SDS-PAGE. Type strains of Bt '*israelensis*' were similarly analyzed for comparison.

In Vitro SBRM Feeding Assay.--Initial experiments with Fluosphere uptake showed a preference for ingestion of spheres in the 0.2 to 1.0 μm range, although some internal fluorescence was observed with all sizes. These spheres were chosen for their size range and sensitivity of detection as a means of defining uptake patterns of Bt crystal and spores by SBRM. These spheres are of the size of many Bt crystals and spores based on published literature.

Concentration of Fluospheres was evident as bright fluorescence within the cibarial-pharynx, midgut, and Malphigian tubules of first instar larvae. Following a time course analysis of Fluosphere uptake combined with different presentation methods, we will evaluate isolates identified as *cry* IV (from PCR profiles) for their toxicity.

RESULTS

Isolation of Bt Strains.--Samples collected from ant hills, horse barns, pastures and river banks all were positive for the presence of Bt. Seventeen new isolates were obtained from these samples and are currently being analyzed biochemically and genetically for differentiation into the four recognized Bt groups. The combination of acetate selection, heat treatment, and ampicillin selection during screening of environmental samples allowed for isolation of Bt with little or no problems with extraneous contaminant organisms. The majority of *Bacillus spp.* identified from this selection procedure were *B. thuringiensis*, characterized as: bacilliform, gram positive, spore forming aerobes, with crystal inclusion bodies. Although acrystalliferous strains of Bt are known to exist, we did not encounter any in our sampling. An additional seven isolates of Bt were obtained from our root and insect sampling studies and similarly characterized.

Protein profiles on SDS-PAGE indicate a pattern almost identical to crystal preparations of '*israelensis*' type strains treated similarly for several of the unknown isolates. Peptides in the 25-28 Kd range and 68-72 kD range are predominant, with some isolates showing a band of approximately 120-130 kD (presumably protoxin). Analysis of fractions from NaBr gradients, however, were less straightforward in that banding on the gradients was irregular and not always reproducible. Protein quantities loaded on gradients were far greater than the sum of bands recovered following centrifugation. Loss of bands in the ranges of active Cry IV toxin moieties (on SDS-PAGE) suggests that at least some of these isolates are solubilized in NaBr during centrifugation. This phenomenon has been noted previously and is associated with isolates encoding Cry III toxins (*i.e.*, coleopteran active strains). We are using a *cry* IV specific oligonucleotide primer in a polymerase chain reaction (PCR) to discern the identity of these isolates. Cry IV toxins have been demonstrated to have activity against numerous dipteran insects, and these are the current focus of our selection protocol.

In Vitro SBRM Feeding Assay.--Fluorescently tagged spheres (Fluospheres) in six sizes (0.2 to 2.5 μm) were placed in 200 μL 0.1% (w/v) sterile sucrose with two or three gnotobiotic first instar SBRM. These were incubated at 24 C for 24 to 28 hours, then washed in 0.1% (v/v) Tween-20 to remove Fluospheres adsorbed to the exocuticula. Larvae were then observed under epifluorescence microscopy to determine uptake of Fluospheres. The pharyngeal ridges of SBRM are known to select particles by size. Fluosphere uptake into the gut will give us an indication of the efficacy of crystal/spore presentation methods to these insects during *in vitro* assays used to screen Bt strains.

SUGARBEET RESEARCH

1992 Report

Section E

Sugarbeet, Bean and Cereal Research Unit
Agricultural Research Service, USDA
East Lansing, Michigan

Dr. J. C. Theurer, Research Geneticist, Plants
Dr. J. W. Saunders, Research Geneticist, Plants
Dr. J. M. Halloin, Plant Physiologist

Cooperation:

Michigan Agricultural Experiment Station
Michigan Sugar Company
Monitor Sugar Company

This research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 700 and 710)

CONTENTS

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION

Hart, S. E., J. W. Saunders, and D. Penner. 1992. Chlorsulfuron-resistant sugarbeet: Cross-resistance and physiological basis of resistance. Weed Sci. 40:378-383.

Greenhouse and laboratory studies were conducted to determine the extent of cross-resistance of chlorsulfuron resistant sugarbeet to other herbicides that inhibit acetolacate synthase (ALS) and to determine the physiological basis of resistance. Cross-resistance to metsulfuron, imazaquin, and imazethapyr was not evident, while only marginal cross-resistance was observed to triasulfuron, DPX-L5300 and nicosulfuron. CR1-B was moderately resistant to chlorsulfuron and chlorimuron and was highly cross-resistant to thifensulfuron and primisulfuron. Further greenhouse studies demonstrated that CR1-B was not significantly injured by thifensulfuron and primisulfuron applied at or exceeding the field use rate. Studies with 14C-primisulfuron concluded that differential absorption or metabolism of primisulfuron could not account for the observed resistance. ALS enzyme assays showed that the CR1-B ALS enzyme activity was 66, 26, and 13 times less sensitive to chlorsulfuron, thifensulfuron, and primisulfuron inhibition, respectively, compared to ALS enzyme extracted from sensitive sugarbeets. An altered ALS enzyme, which is less sensitive to sulfonylurea herbicide inhibition, appears to be the physiological basis of resistance.

Hart, S. E., J. W. Saunders, and D. Penner. 1993. Semi-dominant nature of monogenic sulfonylurea herbicide resistance in sugarbeet. Weed. Sci. (Accepted for publication)

Greenhouse and laboratory studies were conducted to determine the degree of dominance of the monogenic sulfonylurea herbicide resistance trait in diploid sugarbeet by comparing the response of homozygous and heterozygous resistant sugarbeet to primisulfuron, thifensulfuron, and chlorimuron on the whole plant and acetolactate synthase (ALS) enzyme level. Progeny tests suggested that the monogenic sulfonylurea herbicide resistance was semi-dominant. Subsequently, heterozygous resistant (R-1) and homozygous resistant (R-2) sugarbeet lines were sprayed with increasing rates of primisulfuron, thifensulfuron, and chlorimuron, and herbicide rates required for 50% growth reduction (GR50) determined. GR50 values were also determined for susceptible counterpart sugarbeet lines (S-1 and S-2). GR50 values indicated that the R-2 sugarbeet was 377, 269, and 144 times more resistant to primisulfuron, thifensulfuron, and chlorimuron, respectively, than the susceptible counterpart S-2 sugarbeet. In contrast, R-1 sugarbeet was only 107, 76, and 57 times more resistant to primisulfuron, thifensulfuron, and chlorimuron, respectively, than the counterpart S-1 sugarbeet, indicating at least a two-fold difference in the magnitude of resistance between homozygous resistant and heterozygous resistant sugarbeet lines. ALS enzyme activity analysis were consistent with whole plant results. Thus, based on these two criteria, the monogenetic sulfonylurea herbicide resistance trait is semi-dominant in nature, indicating that maximum crop resistance can be obtained by developing homozygous resistant cultivars.

Saunders, J. W., Tsai, C. J., and Samper, E. 1993. Alternative nitrogen and carbon sources for sugarbeet tissue culture. 27th Bien. Mtg. Am. Soc. Sugar Beet Technol. (Abstract).

Conventional plant tissue culture media contains sucrose as a carbon (C) source and a mixture of nitrate and ammonium as nitrogen (N) sources. In order to identify media for selection of biochemical mutants, we examined the ability of the endogenous beet trisaccharide raffinose and one of its constituent monosaccharides, galactose, to serve as sole C source, and of nitrate, ammonium, glutamine, glutamate, proline, urea, choline and glycine betaine (GB) to serve as sole N source for several modes of culture of clone REL-1 in vitro. Raffinose was similar to sucrose in support of suspension culture plate-out (SP) growth, callus initiation with shoot regeneration from leaf discs, and shoot culture (SC). Galactose was moderately supportive of SP growth but was inadequate for leaf disc callusing and SC. Nitrate, ammonium, glutamine, glutamate, and urea, all at 60 mM N, were moderately supportive of SP and SC growth compared to the nitrate-ammonium mix in Murashige-Skoog medium. Proline was poorly supportive, and choline and GB were nonsupportive. Tissue ability to utilize raffinose, glutamine and glutamate precludes their use in media to select for biochemical mutants that accumulate less of these processing impurities. GB utilizing mutants, might, however be selectable with GB as sole N source.

Saunders, J. W., G. Acquaah, K. A. Renner, and W. P. Doley. 1992. Monogenic dominant sulfonylurea resistance in sugarbeet from somatic cell selection. Crop Sci. 32:1357-1360.

Injury to sugarbeets (Beta vulgaris L.) from sulfonylurea herbicide residues from the preceding cropping year has kindled interest in resistant cultivars. Because simply inherited herbicide resistance has been obtained in other crop species through somatic cell selection, this approach was attempted using the annual diploid self-fertile clone REL-1 with its superior shoot regeneration and suspension culture capabilities. Dispersed suspension cultures were initiated from callus induced on REL-1 leaf discs cultured on a modified Murashige and Skoog (MS) agar medium + 1.0 mg/L benzyladenine (BA) and placed in the liquid form of the same medium. Suspensions were subcultured once before plating of unmutagenized cell clusters on solid medium containing 2.8 nM chlorsulfuron in MS + 1.0 mg/L BA. A single colony arose from which shoots were extracted and treated as separate isolates. Shoots were resistant to 28 nM chlorsulfuron, a concentration that killed similar tissues of REL-1. Resistance was recovered in progeny from each of three successive outcrosses to susceptible plants, with segregation indicating a monogenic dominant mode of inheritance. We are proposing the symbols Sur and sur for resistance and susceptibility, respectively. In vitro shoot resistance to chlorsulfuron is 300-1000 fold greater in one isolate than in REL-1. Resistance is also expressed in leaf disc expansion in vitro with MS + 1.0 mg/L BA, suggesting an easy nondestructive method to identify older resistant segregants.

Smucker, A.J.M., and J. C. Theurer. 1992. Fibrous root dynamics of two sugar beet cultivars. ASA-CSSA-SSSA Annu. Meet.; Agron. Abstr. p. 157. (Abstract)

Two sugar beet cultivars, SR87 smooth root type, and MHIE4 standard root type, were planted at row spacings of 25, 40, and 55 cm. Dynamics of the fibrous root systems were monitored for three growing seasons by the minirhizotron and microvideo camera methods. Root images were quantified manually and by image analyses. More fibrous roots were observed in the root zone of the commercial cultivar, during the period from 55-123 DAP, than on the smooth root cultivar. These differences were most obvious within the 0-60 cm depth. Narrow row spacing reduced the size and number of the tap and fibrous roots. Both root systems were the largest at the 55 cm row spacing. Collembola populations, root turnover rates and other root dynamics will be reported.

Theurer, J. C. 1993. A comparison of different types of smooth root and "soil free" sugarbeets. 27th Bien. Meet. Amer. Soc. Sugar Beet Technol. (Abstract)

Field experiments were conducted for a period of three years to compare growth characteristics and agronomic performance of sugarbeet genotypes differing in their taproot architecture. Genotypes were MH E4 and either ACH 176 or ACH 185, commercial hybrids with standard grooved taproots; SR 87, a conical-shaped smooth root (SR) line developed at East Lansing, MI; MM90, a globe-shaped SR experimental triploid hybrid from the Netherlands; and Univers, a European commercial variety that has low soil tare at harvest. In 1992, MM90 produced 42 gm dry matter of tops per plant compared to 75, 106, 108 and 121 gm for Universe, SR 87, MH E4, and ACH 185, respectively. Taproot growth was primarily below the soil level for all genotypes with the exception of MM90, which had only about 50% of the root underground. When averaged over years, root yield for SR 87 was 79.86 Mg ha-1, significantly greater than the 70.72, 72.33, and 62.38 Mg ha-1 for MM90, Univers, and MH E4, respectively. Sucrose percentage for SR87 (15.31%) and MM90 (14.50%) was 1 - 2 percent lower than for the commercial varieties. SR87 was equal to the commercial varieties in sucrose yield per hectare. There was no difference among the genotypes in clear juice purity. MM90 had about half the quantity of soil adhering to the taproots as did SR87 and Univers and about one-fourth that of the standard grooved root type varieties. The SR 87 genotype had higher root yield, sugar yield, and sucrose percentage than MM90. The globe-shaped roots of MM90 were harvested with significantly less soil tare than conical-shaped SR beets. MM90 had the disadvantage of often being dislodged from the row when tops were removed with a rotobeater.

Theurer, J. C. 1993. Fibrous root growth and partitioning in smooth root sugarbeet versus standard root type. J. Sugarbeet Res. 25(1): (In press).

A greenhouse experiment with controlled lighting, temperature, moisture and nutrients was conducted to compare development of the fibrous root system for a smooth root (SR) sugarbeet germplasm with that of four other diverse germplasms having standard grooved root architecture. Comparisons also included partitioning of photosynthate to leaf blade, petiole, taproot, and fibrous root for the five germplasms studied, and for their agronomic performance in a replicated field trial. The SR germplasm produced approximately the same mass of fibrous roots as did the commercial hybrid varieties, Mono-Hy E4 and ACH 176. There was a trend for fibrous roots of the SR line to

develop lower on the taproot, farther from the crown, than standard root types. The SR type had similar leaf area, tap root/leaf blade fresh weight ratio (TLWR), and partitioning of photosynthate to leaf blades, petioles, taproots and fibrous roots as did the commercial varieties. The SR line was more closely aligned with commercial varieties in fibrous root growth and partitioning of photosynthate to plant parts than were the two other standard root type germplasms: EL 46, an inbred selected for high TLWR, and EL 48, a line having superior growth under soil compacted conditions. Greenhouse fibrous root yield and partitioning, supported by agronomic data from this and other (Theurer and Zielke, 1991) field experiments, suggest that SR root types produce a sufficient mass of fibrous roots to transport the required nutrients and water to result in productive yield comparable to standard root architectured sugarbeets.

Theurer, J. C. 1992. Notice of release of smooth root soil-free sugarbeet germplasm SR80.

SR80 is being released as a germplasm source for breeders to use in the development of smooth root breeding lines and cultivars. SR80 is a self incompatable multigerm progeny segregating mainly red hypocotyl color, with moderate resistance to Cercospora leaf spot. Original parentage was from G. W. Demmings' globe-shaped red table beet x sugarbeet selections. Smooth root beets from this population were crossed and backcrossed twice to multigerm eastern U.S. sugarbeet breeding lines considered to have good resistance to Cercospora leaf spot and Aphanomyces root rot diseases, and further developed by six cycles of recurrent mass selection for smooth soil-free roots. In three years of field testing, SR80 averaged 107% root weight, 96% sucrose percentage, and 95% recoverable white sugar per ton compared with the commercial hybrid Mono-Hy-E4. Experimental hybrids having SR80 as pollinator parent averaged 100 - 123% root weight, 93 - 96% sucrose percentage, and 100% of the purity of Mono-Hy-E4. SR80 can be machine harvested with 50 to 60% less soil adhering to the taproots than for the current commercial hybrid Mono-Hy-E4. On a 1 to 5 scale, SR80 has a root smoothness score of 2.25 in comparison to 1.75 for SR87 and 3.25 for Mono-Hy-E4.

Theurer, J. C. 1992. The USDA sugarbeet research unit at East Lansing, MI. Newsbeet (1992 Spring Issue)

The USDA established a sugarbeet research unit at Michigan Agricultural College in East Lansing as early as 1923. First work involved evaluating varieties and determining cultural practices for growing beets. In 1937, the first laboratory was set up to determine sugar percentage and purity. A major effort was made in 1948 to find resistance to black root caused by Aphanomyces cochloides, which was devastating spring stands of beets and forcing sugar factories to close. During the 1950's and 1960's, intensive research effort resulted in development of germplasm with Cercospora leafspot, and black root resistance. Breeders began converting breeding lines to monogermness, and developing parental lines for hybrid varieties. In 1953, scientists investigated seed ripening, germination, and emergence, as there was fear that monogerm seed might result in poor field stands. During 1967-1982, methods were developed for greenhouse evaluation of black root disease. Techniques for artificially

induced field disease nurseries were established for selection of germplasm having Rhizoctonia root rot and Cercospora leafspot resistance. Chemical control of Cercospora leafspot and Rhizoctonia was also investigated. Current USDA sugarbeet research at East Lansing includes: somatic cell selection for nitrogen use efficiency, black root disease resistance and ALS enzyme association with herbicide resistance; development of smooth root-type sugarbeet, improving harvestability, storability and processing efficiency; determining the effects of temperature; and plant-produced antifungal compounds on resistance to root and crown rot.

ALTERNATE NITROGEN AND CARBON SOURCES FOR SUGARBEET TISSUE CULTURE

J. W. Saunders, C. J. Tsai, and E. Samper

Nutritional studies with sugarbeet tissue culture should reflect whole plant nutritional patterns as well as opportunities for mutant selection, for example, for levels of processing impurities. These organic constituents of harvested beets, such as glutamate, betaine and raffinose, can survive the combination of heat and pH changes during processing, remaining inseparable from some of the sucrose in the thick juice. Mutants with altered levels of any of these impurities might be obtainable by selecting for ability of beet cells to grow on these impurities as sole nitrogen (N) and/or carbon (C) sources, if cells do not normally utilize them. This would be similar to the novel glycerol utilization mutant selection reported in tobacco.

Sole Nitrogen Sources. Initial work has been necessary to determine whether glutamate (and less stable glutamine), raffinose or betaine are utilizable by "wild type" sugarbeet cells. The customary nitrogen and carbon sources for plant tissue culture are an ammonium and nitrate mixture (in a roughly 1:2 ratio, at 60 mM, in the Murashige-Skoog formulation), and 2-3% sucrose, respectively. Additional nitrogenous compounds were tested as sole nitrogen sources: nitrate, ammonium, proline (a derivative of glutamate), urea, and choline (a precursor of betaine). An additional novel rationale was conceived for examining some of these nitrogen sources: If a sole nitrogen source would support growth, then resistance to inhibitors of utilization of this compound could be selected for in cultures made vulnerable by the use of that single nitrogen source. Resistance to such inhibitors would likely be based on overproduction of the inhibitor's target enzyme. Overproducer mutants could then be tested in the field for effect on nitrogen use efficiency and juice purity. Furthermore, segregating progeny would easily be tested for identification of individuals overproducing the enzyme by merely screening for those resistant to the inhibitor.

Sole nitrogen source media included source concentrations of 30, 60, and in one case 90 mM. Urea and glutamine have two available nitrogen atoms per molecule. Controls were a

nitrogen-free Murashige-Skoog (MS) medium and a standard MS with 60 mM total N from nitrate and ammonium. Suspension cultures used as inoculum in the plate-outs were washed in nitrogen-free MS medium to remove residual medium nitrogen. Suspension cultures from clone REL-1 were used, 2-3 weeks after initiation from fresh leaf disc callus. Hormone regime was 0.25 mg/L 6-benzyladenine in the test media. Ammonium was provided as the chloride salt in conjunction with succinic acid to avoid the sharp drop in pH that usually leads to death when ammonium is given only with inorganic onions. All nitrogen sources were sterilized by millipore filter and added to the rest of the medium during post-autoclaving cooling. Experiments were terminated before any of the callus began senescence.

Nitrate, ammonium, glutamine (gln), glutamate (glu), and urea supported moderate growth (Fig. 1). Proline supported only poor growth, whereas betaine (bet) and choline (cho) were as ineffective as the nitrogen-free control. Presumably, the minimal growth on nitrogen-free medium was sustained only by intra-or intercellular nitrogen carried in the cell clusters. Betaine, thought to be metabolically inactive in the plant, also appears to be unmetabolized as a nitrogen source for cultured cells.

Subsequent experiments challenged REL-1 cells to utilize glutamine, glutamate and betaine as sole carbon or combination carbon/nitrogen sources. In no case was growth beyond control levels seen (Table 1). From the standpoint of isolating mutants, selection for growth could be done on any of the three substances as sole carbon or sole carbon/nitrogen source, or on betaine as sole nitrogen source. These media could also be used to select for appropriate transformants, such as the use of betaine to identify transgenic cells when transformation with a microbial betaine-degrading enzyme gene is attempted.

Raffinose. The trisaccharide raffinose supported growth about as well as the standard plant tissue culture carbon source sucrose in the initial plate-out experiment. Callus initiation and growth from leaf discs, with subsequent shoot regeneration, were comparable for both sucrose and raffinose at 3% w/w as sole carbon source. It isn't known whether raffinose is broken down metabolically by an invertase, or by a galactosidase to yield sucrose and galactose. Galactose itself supported moderate plate-out callus growth (Fig. 2). Because raffinose is utilized so well by beet callus cells, it is not amenable for simple use in somatic cell selection for lower raffinose levels.

Growth Inhibition by Phenylglyoxal. Given the finding that beet cells grow well with nitrate as a sole N source, we then asked whether growth on nitrate would be vulnerable to phenylglyoxal (PGO), reported to inhibit nitrate uptake in corn roots. At the relatively high PGO concentration of 2100 μM, growth on nitrate was completely inhibited. In order to ascertain whether this inhibition was specific for growth on nitrate, additional experiments were performed to compare the growth response to several concentrations of PGO, with nitrogen presented to the cells as nitrate, ammonium, or an additive mix of the two. We found from these tests that the PGO inhibition of growth at 2100 μM is not specific to nitrate as nitrogen source (Fig. 3). These results seem to foreclose the possibility of obtaining enhanced nitrate uptake mutants by selecting for resistance to PGO on nitrate medium, unless nitrate and

ammonia are taken up by similar systems.

Table 1. Plate out callus growth on three nitrogenous organic constituents of sugarbeets.

	Sole Source		
	N	C	C+N
glutamine	+	-	-
glutamate	+	-	-
betaine	-	-	-

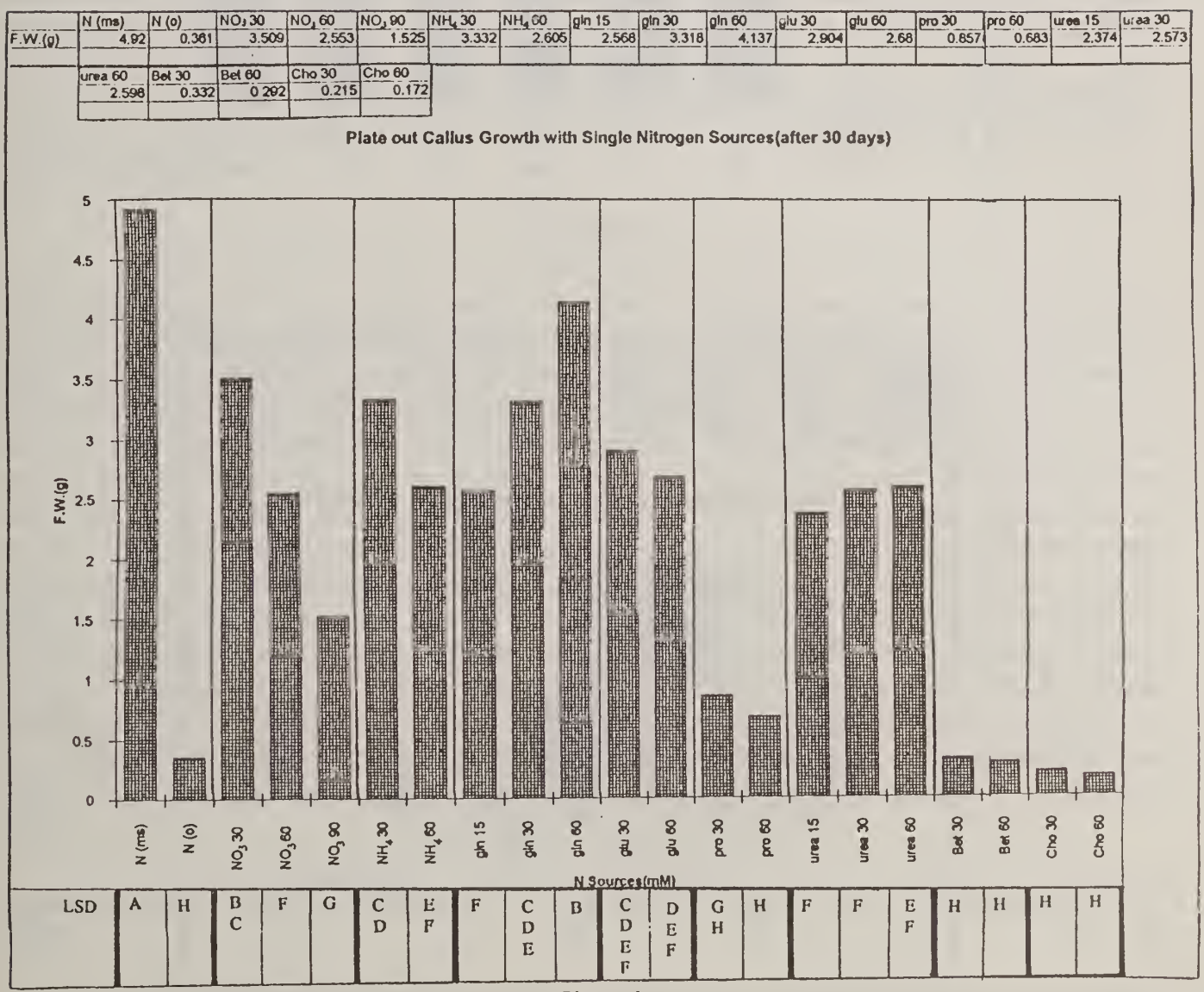

Figure 1

	C (o)	3% Suc	3% Raf	1.5% Gal	2.3% Gal	3.0% Gal	3.8% Gal
F.W.(g)	0.033	2.129	1.698	0.996	1.067	0.855	0.826

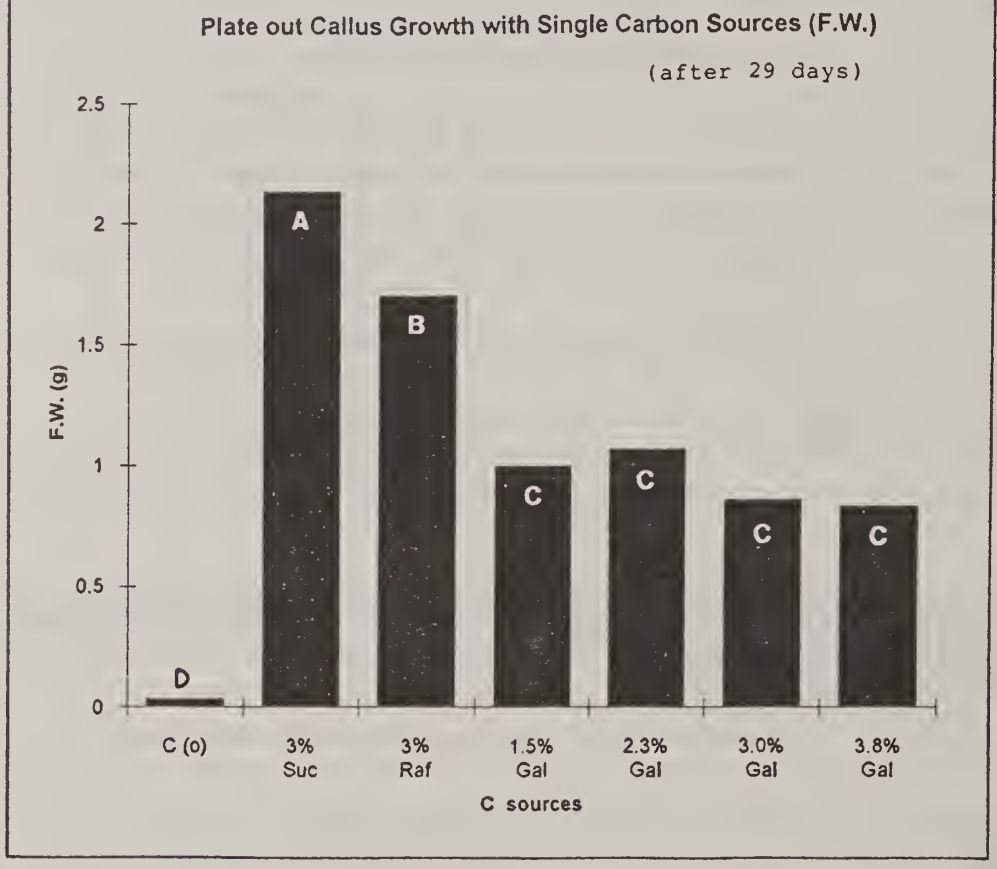

Figure 2

	mix	NO_3 60	$NH_4$60	LSD:		mix	$NO_3$60	$NH_4$60
PGO 0	100%	100%	100%		(PGO)0	A	A	A
PGO 70	66%	91.30%	97.30%		70	B	A	A
PGO 700	24.30%	34.30%	48.30%		700	DE	CD	BC
PGO 2100	3.20%	2.50%	3.10%		2100	E	E	E

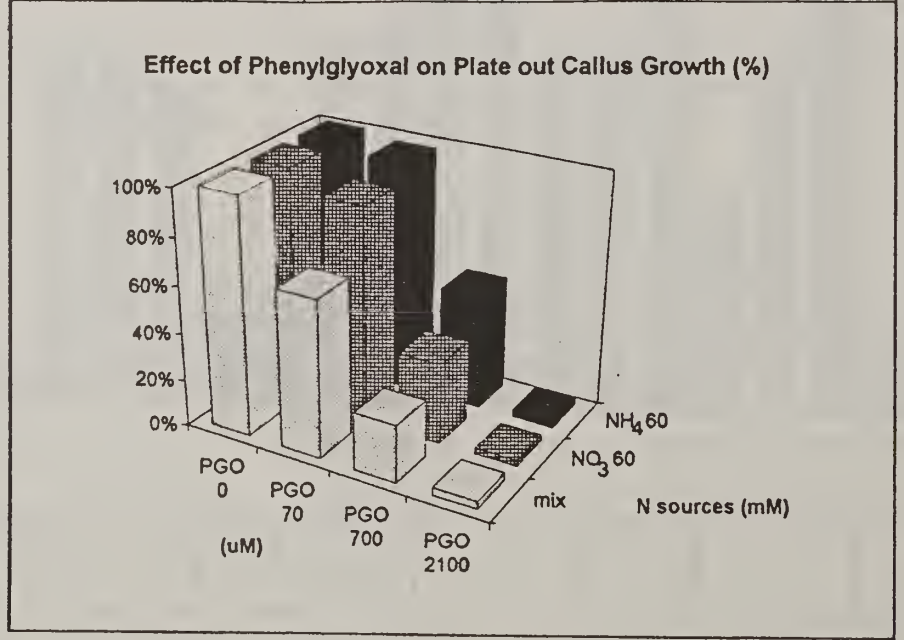

Figure 3

EVALUATION OF SUGARBEET SMOOTH ROOT GERMPLASM. 1992

J. C. Theurer

Evaluation of SR87 and SR80 Experimental Hybrids. A second year's field evaluation was made in 1992 at the Beet and Bean Research Farm near Saginaw, MI for hybrids of SR 87 and SR80, two smooth root breeding lines that were released to the sugarbeet industry in 1990 and 1992, respectively. This experiment was designed to compare SR87 and SR80 genotypes with two commercial cultivars, MHI E4 and ACH 185, and to observe the combining ability of the SR lines when they were each crossed to five CMS lines. Three of the CMS lines were used in common in crosses to SR87 and SR80.

The fourteen entries were planted in two 28" row plots, 30 feet in length in a random block design of six replications. Individual beets were thinned to a spacing of 8-12 inches within the row. All beets in a plot were harvested and weighed for root weight and a 15-beet sample was selected for laboratory analysis to determine sucrose percentage and clear juice purity. These analyses were performed in the Michigan Sugar Company Research Laboratory at Carrollton, MI, using standard methods. A subjective smoothness of root score on a scale of 1 (very smooth) to 5 (grooved/rough) was given to each plot by observing each beet as it fell from the grab rolls into the weighing basket on the harvester. Data were analyzed using MSTAT statistical programs.

RESULTS

Sugar yield, root yield, sucrose percentage, clear juice percentage and smoothness of root scores are given in Table 1. Genotypes SR87 and SR80 were equal to the commercial varieties in root yield, and significantly lower in smooth root score, RWSA, RWST, and sucrose percentage. The experimental hybrids tended to be equal with the commercial varieties in recoverable sugar per acre (RWSA) and clear juice purity percentage (CJP). SR hybrids also were equal or better in tons per acre root yield than the checks. Two of the SR hybrids significantly exceeded the root yield of the checks this year, whereas last year nine of the 10 hybrids out yielded the checks. The commercial varieties had significantly higher sucrose percentage and recoverable sugar per ton (RWST) than the experimental smooth root hybrids, similar to 1991 data. Six SR hybrids had significantly lower smoothness of root score. SR 80 was better than SR87 for sucrose percentage, and most of the SR experimental hybrids with SR80 parentage showed higher combining ability for sucrose than the hybrids with SR87 parentage. SR 80 sucrose percentage was 2.3% lower than that of ACH 185. Marked differences were noted again this year in the effect of the CMS parentage of the experimental hybrids for sucrose percentage and RWST. The 576CMS crosses had the highest values for these two variables both in 1991 and 1992.

Evaluation of F_1 and F_2 Generations of East Lansing High Yield Lines x Smooth Root Lines.

Four high yield East Lansing breeding lines were crossed to smooth root (SR) lines to introduce

the smooth root character into some of the better EL breeding material. The F_1 and subsequent F_2 progenies were planted in two row plots 28 inches wide and 30 feet in length at the Beet and Bean Research Farm for agronomic performance evaluation. There were six replications in the experiment. All roots were harvested for root yield and a sample of 15 roots was selected for sucrose percentage and purity percentage determinations.

RESULTS

The two check varieties had significantly higher RWSA than the experimental hybrids (Table 2). ACH 185 had significantly higher RWST and sucrose percentage than all other entries. F_1 and F_2 progenies of 85300-115x85700-27 and 84B9-71x85700-18 (Codes 3, 5, 7, and 9) had RWST and sucrose percentage equal to MH E4. Three of the F_2 progenies had root yield which was not significantly different from MH E4, the highest yielding check variety. Hybrid 84B2-R14x85700-10 (Codes 6 and 10) was the only entry with clear juice purity significantly lower than the commercial checks. Progenies 5, 9 and 10 had significantly smoother roots than the checks and most other genotypes. In general, the F_2 generation agronomic performance was better than the F_1.

Field Evaluation of Five Smooth Root Populations.

A major problem in the development of SR type sugarbeets is an apparent low sucrose percentage. In this experiment we compared the agronomic performance of five SR genotypes in which attempts had been made to enhance sucrose, with the high sucrose commercial hybrid variety, ACH 185. Two of the genotypes were selections directly from SR breeding material. The other three genotypes were developed from crosses of SR x high sugar lines. The six entries were planted in a random block experiment of four replications with a plot size of two rows 28 inches apart and 30 feet long. In addition to standard agronomic measurements, each entry was scored for smoothness of root on a scale of 1-5 where 1 = very smooth with no vertical grooves on the taproot and 5 = deep grooved rough surfaced root.

RESULTS

Agronomic performance data for this experiment is given in Table 3. Line 91H4, a selection from 85131-16, and 91HS3, a cross of a SR line x AH27, were equal to ACH 185 commercial hybrid in RWSA. The other three SR lines had significantly lower RWSA. Lines 91H4, 91HS1, and 91HS2 had higher RWST than other SR lines but they were all significantly lower than ACH 185. All breeding lines except 91HS1 were equal to the check in root yield. ACH 185 was significantly higher in sucrose percentage than all SR lines. Line 91HS3 had over 2% lower sucrose percentage than ACH 185. Data from this experiment indicate that 91H4 might be a good prospect for release to the sugarbeet industry breeders. However, this line appears to have extreme self sterility and it may be difficult to maintain seed in sufficient quantity to be used in commercial production. Reselection for high yield and high RWST should be made in 91HS2.

Table 1. Sugar yield, root yield, sucrose percentage, clear juice purity percentage, and smoothness score of root score for SR87 and SR80 and experimental hybrids with SR parentage. B&B Farm - 1992

Variety Description	RWSA	RWST	T/A
MHI E4	4950 abc*	242.1 b	20.47 cde
ACH 185	5032 abc	260.7 a	19.32 de
H23CMS x SR80	4948 abc	229.7 bc	21.54 bcd
657CMS x SR80	4581 bcd	227.0 cd	20.19 cde
576CMS x SR80	4782 bcd	232.6 bc	20.61 cde
6926/EL48CMS x SR80	4760 bcd	214.5 de	22.21 bc
BMC CMS x SR80	4550 cd	220.7 cd	20.65 cde
H23CMS x SR87	5191 ab	220.5 cd	23.54 ab
EL36CMS x SR87	5538 a	224.5 cd	24.68 a
576CMS x SR87	4933 abc	230.3 bc	21.43 bcd
657CMS x SR87	5045 abc	224.8 cd	22.43 abc
FC607CMS x SR87	5040 abc	223.4 cd	22.54 abc
SR87	4266 de	206.7 e	20.57 cde
SR80	4187 de	224.8 cd	18.62 e
mean	4843	227.3	21.34
lsd (0.05)	537	12.29	2.13
cv	9.61	4.69	8.67

Variety Description	Sucr %	CJP %	SmRt score
MHI E4	16.87 b	93.83 a	3.35a
ACH 185	17.97 a	94.11 a	3.20ab
H23CMS x SR80	16.01 cd	94.00 a	3.03abc
657CMS x SR80	15.83 de	94.04 a	2.77 bcd
576CMS x SR80	16.25 c	93.87 a	3.18 ab
6926/EL48CMS x SR80	15.47 fg	92.63 ab	3.13 ab
BMC CMS x SR80	15.57 efg	93.55 ab	3.33 a
H23CMS x SR87	15.36 g	94.20 a	2.75 bcd
EL36CMS x SR87	15.66 efg	94.08 a	2.60 cd
576CMS x SR87	15.87 de	94.58 a	2.43 d
657CMS x SR87	15.68 ef	94.05 a	2.23 de
FC607CMS x SR87	15.76 def	93.50 ab	2.60 cd
SR87	15.35 g	91.64 b	1.85 e
SR80	15.64 efg	94.16 a	2.42 d
mean	15.95	93.73	2.78
lsd (0.05)	0.28	1.94	0.48
cv	1.53	1.79	14.93

* Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05 level.

Table 2. Sugar Yield, root yield, sucrose percentage, clear juice purity percentage and smoothness of root score for F1 and F2 EL high yield x Smooth root genetypes. B&B Farm - 1992

Variety Description	RWSA	RWST	T/A
MHI E4	5672 a*	257.5 b	22.04 a
ACH 185	5888 a	275.9 a	21.35 ab
85300-115x85700-27F2	5025 b	246.7 bcd	20.34 abc
85300-33x85700-17 F2	4809 b	235.9 cde	20.41 abc
84B9-71x87500-18 F2	4676 b	253.0 b	18.48 c
84B2-R14x85700-10 F2	4690 b	219.5 f	21.37 ab
85303-115x85700-27F1	4716 b	245.5 bcd	19.22 c
85303-33x85700-17 F1	4537 b	232.4 e	19.53 bc
84B9-71x85700-18 F1	4603 b	248.1 bc	18.56 c
84B2-R14x85700-10 F1	4547 b	234.0 de	19.46 bc
mean	4916	244.8	20.07
lsd (0.05)	473	11.9	1.87
cv	8.2	4.18	8.01

Variety Description	Sucr %	CJP %	SmRt score
MHI E4	17.66 b	94.40 a	3.2 a
ACH 185	18.94 a	94.14 a	3.0 ab
85300-115x85700-27F2	16.97 bcd	94.42 a	2.4 cd
85300-33x85700-17 F2	16.42 de	93.99 ab	2.9 ab
84B9-71x87500-18 F2	17.39 bc	94.36 a	2.0 de
84B2-R14x85700-10 F2	15.82 e	92.59 c	2.6 bc
85303-115x85700-27F1	16.88 bcd	94.43 a	2.8 abc
85303-33x85700-17 F1	16.35 de	93.52 ab	2.8 abc
84B9-71x85700-18 F1	17.28 bc	93.76 ab	1.8 e
84B2-R14x85700-10 F1	16.60 cde	93.08 bc	2.0 de
mean	17.03	93.87	2.5
lsd (0.05)	0.75	0.87	0.4
cv	3.8	.79	14.76

* Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05 level.

Table 3. Sugar yield per acre and per ton, root weight, sucrose percentage, and clear juice purity percentage for smooth root genotypes bred for enhanced sucrose content. B&B Farm - 1992

Variety Description	RWSA	RWST	T/A
ACH 185	6344 a	300.5 a	21.11 a
85131-16 Select	5986 ab	274.3 b	21.81 a
8580-5	5518 bc	248.1 d	22.24 a
(C40x8549-3)x 85700	4998 c	267.0 bc	18.73 b
C40 x 8549-3	5495 bc	269.2 bc	20.42 ab
SR/AH27 F2	5770 ab	261.6 c	22.02 a
mean	5685	270.1	21.05
lsd (0.05)	578	7.9	1.94
cv	6.7	1.9	6.11

Table 3. (Continued)

Variety Description	Sucr %	CJP %
ACH 185	20.33 a	94.61 ab
85131-16 Select	19.04 b	93.63 bc
8580-5	17.06 e	94.42 abc
(C40x8549-3)x 85700	18.04 d	95.04 a
C40 x 8549-3	18.46 c	94.27 abc
SR/AH27 F2	18.35 cd	93.28 c
mean	18.55	94.21
lsd (0.05)	0.41	1.21
cv	1.47	0.85

* Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05 level.

A COMPARISON OF DIFFERENT TYPES OF SMOOTH ROOT AND "SOIL FREE" SUGARBEETS

J. C. Theurer

Large quantities of tare soil harvested with sugarbeet taproots increase transportation costs, contribute to increased respiration and sugar loss in storage piles, and can be a means of spreading serious soil-borne diseases. In recent years, considerable interest has been generated in the development of smooth root (SR) and "soil free" varieties.

An experiment was planted May 27, 1992, in sandy loam soil at the Botany Research Farm in East Lansing to compare the agronomic performance of smooth root (SR) genotypes with a European "soil- free" variety and two U.S. commercial sugarbeet hybrids. This year was the third season for comparison of the growth characteristics and the agronomic performance of these genotypes.

There were six genotypes in the 1992 field trial. Three were commercial hybrids with standard grooved root architecture: MHI E4, ACH 185, and the European soil-free variety, Univers. Two were SR type: A90-MM, a globe-shaped beet developed by Dr M. Meskin at the Wageningen, Netherlands breeding station; and the smooth root line, SR87, developed at East Lansing. The sixth variety was an experimental hybrid of 756CMS x SR87. The experiment was a randomized block of five replications. Individual field plots consisted of two rows 28" apart and 30 feet long, with beets spaced 8"-12" within the row.

The experiment was harvested on November 3, 1992. Two representative tops were removed from each entry and weighed just prior to harvest. These samples were dried in an oven at 85 F and re-weighed and the data was used to calculate the dry weight of the tops of the genotypes. Tops were removed from the other beets in the experiment with a tractor-mounted rotobeater. Roots were dug with a single row miniharvester

having puller wheels and a series of star rinks similar to the standard commercial machines used for beet harvest. The roots from each plot were placed in bags with care to avoid knocking off soil that was adhering to each root. Subsequently, the soil was scraped from the roots and the weight of clean root and soil harvested with the roots was determined. A sample of soil from each plot was dried in an oven at 85 F to determine the dry weight of soil. Each root was classified for smoothness of root on a scale of 1 to 5 where 1 = very smooth roots without grooves and 5 = rough shaped roots with deep grooves or sprangled roots. About 15 roots from each plot were taken to Michigan Sugar Company Research Laboratory at Carrollton, MI, for determination of sucrose percentage and clear juice purity.

RESULTS AND DISCUSSION

The MM90 hybrid had the smallest tops, producing only 42 grams of dry matter per plant compared to top dry weights of 75, 106, 108 and 121 grams for Universe, SR 87, MH E4, and ACH 185, respectively (Table 4). The globe-shaped SR genotype grew like a table beet with about 50% of the root out of the ground. This made it difficult to remove the tops with a rotobeater without dislodging the beets from the soil. SR 87 was similar to the commercial varieties in growth habit where the taproot growth was primarily below the soil level.

Univers, SR 87, and the 576CMS x SR 87 hybrid had significantly better RWSA than the MM90 globe-shaped hybrid. SR 87 and its hybrid also were significantly higher in root yield than the other entries. ACH 185 had the highest sucrose percentage and RWST. The smooth root genotypes were 2-3% lower than the checks in sucrose percentage and also significantly lower in clear juice purity percentage. The smooth root genotypes and Univers had significantly lower smoothness scores. SR87 had about 50% of the quantity of soil harvested with the roots as did the standard commercial hybrids MHI E4 and ACH 185. MM90 had about half the quantity of soil adhering to the taproots as did SR87 and Univers and about one-fourth of that of the other standard grooved root type varieties.

The data demonstrate that globe-shaped SR beets can be harvested with less soil tare than conical-shaped SR beets; however, they may be more difficult using present harvesting equipment, because of the beets being dislodged from the row when tops are flailed. Globe or round shaped beets could be better harvested using the old Scott viner principle of lifting the roots from the soil by their tops and then severing them from the taproots. Our opinion is that a top/conical shape is the best model of root architecture for economical sugarbeet production.

Table 4. Root yield, Sugar yield, Sucrose %, Clear Juice Purity %, smoothness score, and pounds soil/ton of beets for smooth root, experimental smooth root hybrids and commercial hybrid varieties. East Lansing, MI. 1992.

Variety	RWSA	RWST	T/AC
MHE4	5582 ab*	247.3 b	22.59 bc
ACH185	5498 ab	268.3 a	20.48 c
Univers	5638 a	226.8 c	24.85 bc
Mesken Globe	4503 b	201.6 d	22.45 bc
SR87	6157 a	204.4 d	30.15 a
576 x SR87	5987 a	227.5 c	26.27 ab

Variety	Suc. %	CJP %	SR. Score	Soil/ Ton Beet
MHE4	17.40 b	93.28 a	3.38 a	434.5 a
ACH185	18.65 a	93.60 a	3.03 ab	481.7 a
Univers	16.23 c	92.81 ab	2.58 c	250.4 b
Mesken Globe	14.97 d	91.51 c	2.00 d	121.3 c
SR87	14.94 d	92.16 bc	1.58 e	230.3 b
576 x SR87	16.12 c	93.17 a	2.77 bc	271.2 b

* Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05 level.

1992 EXPERIMENTS OF GENOTYPE X NITROGEN RESPONSE

J. C. Theurer and J. W. Saunders

Nitrogen fertilization is an important aspect for growing a good sugarbeet crop. Sufficient N is required for the beet to make rapid growth in the spring and to quickly develop a canopy of leaves for photosynthesis, further plant growth, and sucrose accumulation. Excess N at harvest results in higher impurities in the root and more difficulty in processing to sugar. In 1990 a research program was initiated to evaluate diverse genotypes for their potential difference in tolerance to high N or their efficiency in sugar production with low nitrogen availability. Several field experiments were conducted in 1992 to observe variation for nitrogen use response.

Nitrogen Response for High Sugar Varieties. A group of high sucrose experimental hybrids were evaluated in 1990 and 1991 for their response to differential N levels (i.e.,

fertilization at rates of 0, 60, 120, and 180 lb. N/acre). Minor differences in N response were noted among some of the varieties for the two years. This 1992 field test was to be a third year evaluation of four of the hybrids which had shown the most variation in response to N fertilizer levels. However, due to a miscommunication, the field was fertilized at the time of planting with the Michigan standard recommended rate of 90 lbs N/acre. The first week of July an additional 55 lb. and 110 lb. N were applied to parts of the field to still create differential N treatments of 90, 145, and 200 lb. N/acre. There were four replications for each variety. Individual plots were standard two rows 28 inches apart and 30 feet long.

RESULTS

Agronomic performance data showing RWSA, RWST, tons/acre, sucrose percentage, CJP percentage, and meq amino N/100 grams sugar are listed in Table 5. The ANOVA showed significance for nitrogen levels and for varieties. The nitrogen x variety interaction was nonsignificant for each variable that was measured, indicating that the five varieties were performing similarly with each N treatment. Although the N_3 treatment had the highest RWSA, differences between the N levels were not significant. MHI 5135 and ACH 85-153 were significantly higher in RWSA and root weight than the other varieties. With the exception of MHI E4, all of the varieties had about the same level of RWST. Each increment of increased N fertilizer had the effect of significantly reducing the RWST and the sucrose percentage. The two higher N levels increased root yield significantly over that of the N_1 treatment. Summed over N treatments there was no difference among the varieties for either clear juice purity or for the quantity of amino N in the root at harvest. The N_3 treatment gave significantly lower CJP percentages than the other N treatments and significantly higher meq amino N/gram of sucrose. There were no differences between N_1 and N_2 fertilizer treatments in meq amino N.

Selection in Diverse Breeding Populations For Nitrogen Use Efficiency. Sixteen diverse sugarbeet germplasms, including two commercial hybrids and a high yield-low sugar percentage fodder beet were planted in a replicated field trial to investigate the possibility of identifying germplasms favorable for potentially increasing nitrogen use efficiency in sugarbeet. One section of land for the split plot experiment was fertilized with potassium and phosphate fertilizer at recommended rates based on soil testing, without any added nitrogen. An adjacent section of the field was fertilized at the time of planting with recommended rates of potassium and phosphate plus 90 lb. available N per acre. The first week of July an additional 90 lb. N was broadcast on the latter field bringing the total nitrogen application to 180 lb. N/acre, twice the normal recommended rate for sugarbeets in Michigan. The zero rate was used in an effort to identify genotypes with the ability to more efficiently utilize a limited amount of N for production. The high N rate was used in an attempt to find genotypes that would utilize an excess amount of nitrogen without the typical significant decrease in sugar percentage coupled with greater impurities in the root, particularly amino N. There were four replications in the experiment and the individual plots were two rows 28 inches apart and 30 feet long. The plots were machine harvested the first week of October and all roots

of the plot were weighed to determine tons/acre yield. Well-shaped individual roots for breeding were selected from the weighing basket before the roots were dumped into the harvester tank. Half of each root was processed for a juice sample for laboratory analyses. Also, a 15-beet sample was taken from each plot for sucrose percentage, CJP percentage, and meq amino N determinations. The laboratory analyses were performed by Michigan Sugar Company personnel at their research laboratory at Carrollton, MI.

RESULTS

Significant differences were observed for root production, sucrose yield, and quality factors between nitrogen levels (Table 6). Recoverable sugar per acre (RWSA), tons per acre, and meq amino N, were higher at the 180 lb. N level than at the zero N level. Recoverable sugar per ton (RWST), sucrose percentage, and clear juice purity (CJP) were lower for the 180 lb. rate. Recoverable sugar per acre (RWSA) under the zero fertilizer treatment was only about 60% of the production under the high N treatment. The high nitrogen treatment on average reduced the sucrose percentage by 1.4% and significantly reduced CJP percentage. The meq amino N/100 grams sucrose in the root at harvest was 2.25 times higher than that observed for the average of the zero N treatment.

In general, individual genotypes used in this study showed similar response for the two nitrogen levels as cited above for the overall means. However, the ANOV showed significance for N level x genotype interaction for RWSA, RWST, sucrose %, CJP %, and meq amino N. The high fertilizer level increased the RWSA of two genotypes, 88B23-00 and 88B24-01, more than any of the other entries. Excluding the hybrid check varieties, genotype WC79438 had the highest sucrose percentage at the zero N level and 88B23-00 at the 180 lb. N level. Blanca fodderbeet and genotype 87B30-5 were highest in amino N in the root at harvest at the zero level and WC90319 was highest at the 180 lb. rate. Genotype 89B2-15 was lowest in amino N at zero N rate and 8541-0 was lowest at the 180 lb. treatment.

Comparison of the multiple range tests for each entry within fertilizer levels showed several interesting interactions of N rate x genotypes. Seven genotypes (3, 4, 5, 6, 12, 13, and 15) considered individually, were significantly higher in RWSA than many other genotypes when produced under the 180 lb. N treatment, whereas under the zero treatment they exceeded few entries. Genotypes 7, 10, 11, and 14 showed the effect of producing significantly less RWSA than most other genotypes when they were grown at the high N level. Genotypes 88B24-01 and 88B23-00 were significantly higher in sucrose percentage than most others when they were evaluated at the 180 lb. N rate but not at the zero rate. This suggests that these lines may be more efficient in their utilization of high levels of N with less inverse effects upon sucrose content. Contrariwise, two genotypes (88B19-00 and WC90318) were significantly lower in sucrose percentage than most other genotypes at the high N level, but not at the zero rate. This might indicate that these genotypes are more adversely affected in their ability to produce high sugar percentage in high N environments. Similar genotype x N rate

interactions were observed for amino N when the multiple range tests at the two N levels were compared. Genotypes 3, 4, 5, 6, and 15 showed significantly higher amino N than many other genotypes when grown in the 180 N environment, but not at the zero N level. Genotypes 7, 8, 9, 10, 11, 12, and 14 each showed significantly lower amino N than many genotypes at the high N rate, but not at the low N rate. Roots have been saved from genotypes that show possibility for enhancing N efficiency in sugarbeets for seed production, subsequent evaluation, and re-selection.

Selection for High Sucrose Percentage, High Amino N and Low Amino N in the L19 High Sucrose Genotype. Experiments in 1990 with diverse high sugar genotypes demonstrated that the L19 genotype, which had the highest sugar percentage of all entries, also had high accumulation of amino N in the roots at harvest. In 1991, L19 was planted in two large selection blocks. One had zero nitrogen applied during the growing season; the other was fertilized with 180 lb. available N, which was about twice the recommended rate of nitrogen application for growing a crop of sugarbeets in Michigan. Competitive roots within each block were harvested by hand in late September. Half of each selected root was analyzed at the Michigan Sugar Company Research Laboratory at Carrollton, MI, for sucrose percentage and amino N. The other half of the root was retained in cold storage for breeding. Selections were made for high sucrose, high amino N, and low amino N, and seed increases were made in the greenhouse during the 1991-92 winter.

Five progenies selected from the high sugar line L19 grown in low and high N field plots were planted in a replicated field trial in 1992 along with the parent line. Plot size was two rows 28 inches apart and 30 feet long, planted in four replications of a random block design. The study was done to assay the effect of high and low N fertilization on the inverse relationship of sucrose percentage and amino N impurities in the beet in high sucrose lines. Three of the selections were from seed increases of beets selected for high sucrose, high amino N, and low amino N in the 1991 low N field plot. The two other progenies were high sucrose and high amino N from beets selected in a field that had been fertilized with 180 lb. available N/acre. A low amino N selection was also made from the 1991 high nitrogen field plot. However, there was an insufficient quantity of seed to field test this selection. The 1992 field plot was fertilized preplant with the standard recommended fertilizer rate (90 lb. N/acre) for growing sugarbeets in Michigan.

RESULTS

Recoverable sugar per acre (RWSA), root weight, and clear juice purity were not different for the five progenies (Table 7). Sucrose percentage and recoverable sugar per acre (RWST) was highest for the high sucrose selections. The high sucrose selections were also significantly higher in sucrose than the parent line. Unexpectedly, the low amino N selection (92SN19-01) was significantly lower in sucrose percentage than the high amino selection (92N19-01) from the 1991 low N field. The high amino N selection from the 1991 low N field also had significantly higher meq amino N/100 gm sugar than the other two selections. The high sucrose selection from the 1991 high N

field group had significantly greater amino N than the high amino selection. The data demonstrate that selection for high sucrose percentage and amino N was effective when selection was made in a low N field environment, but not in a high N field environment. Data also show that there is not a direct inverse relationship of high sugar and low amino N impurity in the beet at harvest for the L19 high sugar line.

Evaluations of 1991 Nitrogen Use Efficiency Selections Made in a Low N (Zero lb. N/Acre) Field. In 1991, a series of 13 sugarbeet breeding lines of wide diversity were planted under low (no nitrogen fertilization) and high (180 lb. available N per acre) for yield and sucrose evaluation. The purpose of the experiment was to see if there were differences in the way the genotypes responded to nitrogen, and to make selections for N use efficiency. The goal under the low N treatment was to select beets that demonstrated their N use efficiency by producing good yield and high sugar content in the absence of what might be termed optimal fertilization (usually 90-100 lb. N/acre for Michigan). Selection in the high nitrogen treatment (see next section of this report) was aimed at isolating genotypes that had the ability to metabolize high N levels to an advantage giving rise to larger yields without appreciable loss of sucrose content nor substantial rise in nitrogenous impurities in the sugarbeet root at harvest.

Individual beets with high RWST, low amino N in the root at harvest, and above average sucrose percentage were selected from four lines that showed the most promise for giving a high sucrose yield with low amino N content. In 1992 field trials, we compared the agronomic performance of the four selected progenies with their parent genotypes. The eight entries were planted in two-row plots with rows 28 inches apart and 30 feet long. There were four replications in the experiment.

RESULTS

A serious outbreak of Rhizoctonia root rot occurred in this field trial and the plant stands in all plots had to be adjusted to correct for bias. Thus, the results of the test are not as reliable as they might have been with better plant stand. There was a marked difference between the genotypes and their response to selection pressure (Table 8). Genotype 92N1 had higher RWSA and tons/acre root weight than the parent line 90S1, but it was not better for sucrose percentage, RWST, or clear juice purity. Selection 92N3 compared to its M101 Canadian parent line had significantly better RWSA, RWST, sucrose percentage, and clear juice purity percentage. The selection was not better than the parent in amino N. The 92N7 selection showed no differences from the parent line. Likewise, selection 92N8 was similar in sucrose percentage, RWST, RWSA, and amino N, but it produced significantly less root weight than the parent population.

Evaluations of 1991 Nitrogen Use Efficiency Selections Made in a High N (180 lb. N/acre Field. Individual beets were selected from the 1991 high N fertilization unit noted in the previous section. These selections were from four lines which showed the greatest promise for retaining high sucrose percentage and also having the lowest amino

N content in the root at harvest. Seed increases of the selected genotypes were made in the greenhouse during the winter of 1991-92. The four selections, with their respective parent lines, were planted in 1992 in a field experiment at the B&B Farm at Saginaw, MI to evaluate the efficacy of selecting for genotypes that could more efficiently use a luxuriance of nitrogen. There were four replications of a randomized block experiment. Plot size was two rows 28 inches apart and 30 feet long. The 1992 field was fertilized at the standard recommended rate of 90 lb. N/acre.

RESULTS

Similar to experiment 9212, there was a serious infection of Rhizoctonia root rot in the field where this experiment was conducted. Although stands were corrected for row lengths where there were no beets, this disease situation may have had some effect on the accuracy of the data that was collected. There were no significant differences between any of the selections and their respective parent genotypes for RWSA, RWST, sucrose percentage, root weight, clear juice purity, or amino N in the roots at harvest (Table 9). Thus, selection for N use efficiency in the 1991 high N field was completely ineffective.

Table 5. Comparative yield, sucrose percentage and impurities of high sugar experimental hybrids grown in the field with excessively high rates of nitrogen. B&B Farm - 1992.

N	Variety	RWSA	RWST	T/A	Sucr %	CJP %	Am N
1		5709	293.7	19.39	19.95	94.47	6.51
2		6185	286.4	21.60	19.53	94.35	6.68
3		6432	280.2	22.94	19.28	93.97	8.58
	sd	203	1.3	0.64	0.08	0.09	0.22
	lsd (0.05)	702	4.5	2.20	0.26	0.30	0.77

	Variety	RWSA	RWST	T/A	Sucr %	CJP %	Am N
	ACH 185	5643	274.9	20.53	18.77	94.40	7.66
	MHI 5135	6929	289.1	23.98	19.84	93.99	6.84
	ACH 185	5879	289.7	20.32	19.75	94.32	7.40
	ACH 85-153	6540	291.0	22.49	19.75	94.53	7.15
	BETA 5315	5551	289.2	19.23	19.82	94.07	7.24
	sd	123	2.1	0.43	0.08	0.21	0.41
	lsd (0.05)	ns	6.1	1.24	0.22	ns	ns
		1721				0.61	1.17

N	Variety	RWSA	RWST	T/A	Sucr %	CJP %	Am N
1	ACH 185	5175	276.4	18.69	19.01	94.06	7.75
	MHI 5135	6668	297.2	22.40	20.20	94.40	5.86
	ACH 185	5131	297.8	17.18	20.09	94.79	6.48
	ACH 85-153	6239	299.2	20.82	20.14	94.86	6.55
	BETA 5315	5330	298.0	17.87	20.32	94.25	5.92
2	ACH 185	5777	278.9	20.69	18.82	94.97	6.44
	MHI 5135	7124	285.2	25.01	19.71	93.70	7.27
	ACH 185	6061	285.3	21.25	19.52	94.20	7.39

Table 5. (Continued)

	ACH 85-153	6705	294.6	22.75	19.86	94.84	5.88
	BETA 5315	5261	288.0	18.29	19.75	94.05	6.44
3	ACH 185	5978	269.3	22.20	18.50	94.18	8.77
	MHI 5135	6996	284.8	24.53	19.62	93.87	7.40
	ACH 185	6446	286.1	22.53	19.66	93.98	8.33
	ACH 85-153	6676	279.2	23.90	19.25	93.89	9.02
	BETA 5315	6064	281.4	21.54	19.38	93.91	9.36
	sd	214	3.7	0.75	0.13	0.37	0.71
	lsd (0.05)	ns	10.49	2.14	0.37	ns	2.03

Table 6. Recoverable sugar per acre and per ton, root weight, sucrose percentage, clear juice purity percintage, and meq amino N/100 grams sugar for 16 germplasms at 0 and 180# N/acre. B&B Farm - 1992

Variety	Description	RWSA	RWST	T/A
1	ACH 185	3460	289.1	11.96
2	BETA 5315	3354	296.6	11.32
3	88B24-01	3199	271.4	11.80
4	88B19-00	3128	260.7	12.00
5	88B23-00	2913	271.9	10.68
6	89B2-15	3703	265.4	13.98
7	89B9-15	2748	260.4	10.58
8	WC86054	3081	261.8	11.78
9	WC79438	2743	279.1	9.83
10	88EL303	2901	275.6	10.53
11	85B41-00	2585	263.5	9.81
12	90F2	3119	271.5	11.49
13	87B30-5	3268	258.5	12.70
14	WC90318	2660	262.8	10.12
15	8541-0	2532	275.5	9.20
16	Blanco	2727	179.0	15.26
	mean	3008	265.2	11.44
	lsd(0.05) at 0 N	479	12.9	1.95
	cv	11.2	3.4	11.98

Variety	Description	RWSA	RWST	T/A
1	ACH 185	5710	266.8	21.35
2	BETA 5315	5128	256.5	20.05
3	88B24-01	5981	251.0	23.83
4	88B19-00	5293	240.4	22.00
5	88B23-00	5396	250.7	21.55
6	89B2-15	5933	237.3	25.00
7	89B9-15	4983	222.9	22.35
8	WC86054	4943	233.7	21.19
9	WC79438	4871	245.0	19.88
10	88EL303	5110	234.9	21.80
11	85B41-00	3569	234.6	15.19
12	90F2	4904	246.6	19.87
13	87B30-5	5347	236.3	22.60
14	WC90318	3968	216.5	18.31
15	8541-0	4891	253.0	19.33
16	Blanca	3921	149.9	26.19
	mean	4997	236.0	21.28
	lsd(0.05) at 180 N	559	9.6	2.62

Table 6. (Continued)

cv	7.87	2.87	8.65
sd(all varieties/both N)	183	4.0	0.81
lsd(0.05)	514	11.3	2.28

Variety	Description	Sucr%	Amino N CJP%	Amino N /100 g
1	ACH 185	19.62	94.57	4.58
2	BETA 5315	20.07	94.63	4.26
3	88B24-01	18.58	94.32	4.99
4	88B19-00	17.94	94.21	5.89
5	88B23-00	18.44	94.80	4.96
6	89B2-15	18.22	94.28	4.66
7	89B9-15	17.85	94.37	6.02
8	WC86054	17.97	94.30	6.48
9	WC79438	18.90	94.78	5.77
10	88EL303	18.75	94.58	5.03
11	85B41-00	18.22	93.91	5.88
12	90F2	18.56	94.38	5.22
13	87B30-5	17.61	94.74	6.50
14	WC90318	17.98	94.46	6.38
15	8541-0	18.69	94.73	4.88
16	Blanca	13.64	90.80	11.58
	mean	18.19	94.24	5.82
	lsd(0.05) at 0 N	0.78	0.69	1.75
	cv	3.02	0.52	21.16

Variety	Description	Sucr%	CJP%	AminoN /100 g S
1	ACH 185	18.61	93.48	9.65
2	BETA 5315	18.36	92.42	9.44
3	88B24-01	17.72	93.07	10.58
4	88B19-00	16.84	93.60	11.60
5	88B23-00	17.46	93.74	10.58
6	89B2-15	16.64	93.59	10.54
7	89B9-15	16.26	91.94	14.30
8	WC86054	16.63	92.93	12.95
9	WC79438	17.24	93.30	13.29
10	88EL303	16.89	92.43	12.70
11	85B41-00	17.00	92.08	14.07
12	90F2	17.24	93.59	14.85
13	87B30-5	16.61	93.49	12.47
14	WC90318	16.07	91.26	18.42
15	8541-0	17.25	93.84	9.46
16	Blanca	12.02	89.34	24.46
	mean	16.80	92.76	13.09
	lsd(0.05) at 0 N	0.47	1.12	2.04
	cv	1.97	0.85	10.98
	sd (Over All N rates /All varieties)	0.23	0.33	0.67
	lsd (0.05)	0.64	0.92	2.59
	cv	2.59	0.70	14.2

Table 7. Evaluation of L19 progenies selected for high sugar percentage, high or low amino N/ 100 grams sugar. B&B Farm - 1992.

Selection Seed No.	Selection Basis	RWSA lbs	RWST lbs	Root Wt. Tons/Ac
	Low Nitrogen Field Plot			
92S19-01	High Sucrose	3259 b*	243.7 a	13.44 b
92SN19-01	High Amino N	3339 b	230.5 ab	14.46 ab
92N19-01	Low Amino N	3215 b	220.6 b	14.52 ab
	High Nitrogen Field Plot			
92S19-02	High Sucrose	3397 b	240.1 a	14.15 ab
92N19-04	High Amino N	3428 ab	229.4 ab	14.96 ab
L19	High Sucrose Parent Line	3822 a	237.8 a	16.11 a
mean		3410	233.7	14.60
lsd (0.05)		419	15.3	2.19
cv		8.14	4.3	9.25

Selection Seed No.	Selection Basis	Sucrose %	CJP %	Amino N meq/100 g
	Low Nitrogen Field Plot			
92S19-01	High Sucrose	16.60 a	89.78 a	19.96 d
92SN19-01	High Amino N	17.56 bc	89.96 a	25.57 a
92N19-01	Low Amino N	16.81 d	90.09 a	21.59bcd
	High Nitrogen Field Plot			
92S19-02	High Sucrose	17.98 ab	90.56 a	23.50 ab
92N19-04	High Amino N	17.34 cd	90.31 a	21.26 cd
L19	High Sucrose Parent Line	17.80 bc	90.61 a	23.06 bc
mean		17.68	90.22	22.49
lsd (0.05)		0.63	1.47	2.08
cv		2.36	1.08	9.13

*Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05 level

Table 8. Sugar yield, root yield, top weight, sucrose percentage, clear juice purity percentage, and meq. amino N/100 grams sugar of selections made for N use efficiency when grown under low nitrogen. B&B Farm 1992.

Variety	RWSA	RWST	T/A
92N1	3326	231.6	14.39
90S1	2083	229.3	9.12
92N3	4126	224.7	18.38
89H18	3196	207.5	15.43
92N7	3462	229.6	15.13
88B190	3781	227.1	16.66
92N8	2904	226.2	12.84
88B23-00	3228	221.8	14.55
mean	3263	224.7	14.56
lsd (0.05)	885	12.2	4.30
cv	15	3.1	16.86

Variety	Sucr %	CJP %	Amino N meq
92N1	17.15	91.15	14.81
90S1	17.32	90.36	14.05
92N3	16.15	92.59	12.53
89H18	15.49	91.15	13.03
92N7	16.57	92.33	10.36
88B190	16.29	92.67	10.42
92N8	16.46	92.02	11.72
88B23-00	16.18	91.95	13.15
mean	16.45	91.78	12.51
lsd (0.05)	0.63	1.11	3.40
cv	2.20	0.69	15.54

Table 9. Sugar yield, root yield, sucrose percentage, clear juice purity percentage, and meq amino N /100 grams sugar of selections made for N use efficiency when grown under high nitrogen level. B&B Farm - 1992.

Variety	RWSA	RWST	Sucr %	CJP %	T/A	meq Amino N 100 g sucr
92N12	3563a	186.2ab	14.45ab	89.86ab	19.07a	20.90ab
88B24-01	3471a	189.4ab	14.49ab	90.41ab	18.31a	20.43ab
92N13	3275a	174.5b	13.69b	89.67b	18.79a	21.62a
88B-00	3417a	188.1ab	14.37ab	90.50ab	18.17a	20.0abc7
92N21	3194a	187.9ab	14.42ab	90.31ab	17.01a	20.17abc
88B19-00	3494a	191.9ab	14.91a	89.79ab	18.21a	19.71abc
92N18	3808a	197.6a	14.77a	91.30a	19.30a	17.88bc
89H18	3339a	188.9ab	14.42ab	90.52ab	17.72a	17.13c
mean	3445	188.0	14.44	90.29	18.32	19.74
cv	12	5.4	3.88	1.00	10.30	9.34
lsd (0.05)	737	17.6	0.98	1.59	3.30	3.23

EVALUATION OF COMBINING ABILITY OF A HIGH RWST SELECTION FROM THE HIGH SUGAR LINE L19.

J.C. Theurer

L19, a very high sugar percentage line, was released to the sugarbeet industry several years ago. This line not only was mediocre in root yield, but it had the undesirable characteristic of a multiple crown. Selection was made in 1990 in a block planting of Line L19 for large well shaped roots, single crown, and high RWST. The selected roots from L19 were increased by open pollination to produce 88S9-02. This line was used as a pollinator with five CMS lines to obtain experimental hybrids for observing the combining ability of the new L19 selection.

In 1992, we compared the performance of Line L19, the selection made from this population (88S9-02), and the five experimental hybrids made using 88S9-02 as pollen parent. Four other entries were included in the field test: MH E4 and ACH 185 commercial hybrid checks; a composite population which included L19; smooth root, high yield, and monogerm genotypes; and a hybrid of L19 with C51, another high sugar line. The experiment was planted at the B&B Farm in 1992 in six replications of a random block experiment. Individual plots were two rows 28 inches apart and 30 feet long.

RESULTS

Performance data for the field trial are listed in Table 10. The L19 selection (Code 8) resulted in beets with less multiple crowns than observed for the L19 parent population (Code 9). The selection produced three tons per acre more beets and was significantly superior to the L19 parent in both root yield and sugar yield (RWSA). There was no difference between the L19 parent population and the selection in sucrose percentage and clear juice percentage. Compared with the check varieties, the L19 genotypes were significantly lower in root yield, higher in sucrose percentage and RWST, and equal in CJP percentage. The five hybrids with 88S9-02 showed good combining ability for RWST, RWSA, tons/acre, sucrose percentage and CJP percentage, equal to the checks in most cases. ACH 185 had a significantly higher sucrose percentage than the experimental hybrids with the exceptions of 576CMS x 88S9-02 and C51 x L19. The C51 high sugar line had a negative effect on L19 as evidenced by the reduction in yield of sugar, root yield, and sucrose percentage. Thus, it does not appear that C51 carries genes that would compliment those of L19 to enhance sucrose accumulation in the beet. The composite population (Code 10) had good RWSA, tons per acre root yield, and purity. It was over 2% lower in sucrose percentage and had about 42 lb. less RWST than the L19 lines.

Table 10. Recoverable sugar per acre and per ton, root weight, sucrose percentage, and clear juice purity percentage for L19, L19 Select and hybreds with L19 Select parentage. B&B Farm 1992

	Variety	Description	RWSA	RWST	T/A
1	MHI E4	MHI E4	5461 bc*	259.6 de	21.03 ab
2	ACH 185	ACH 185	5760 abc	277.1 bc	20.72 b
3	WC91266	H23CMS x L19 Select	5809 abc	264.1 cd	22.04 ab
4	WC91267	657CMS x "	5809 abc	267.4 cd	21.75 ab
5	WC91268	576CMS x "	6236 a	276.4 bc	22.58 ab
6	WC91269	BMC CMS x "	6039 ab	258.4 de	23.38 a
7	WC91270	FC607CMS x "	5909 ab	267.3 cd	22.09 ab
8	WC91270M	88S9-02 x "	5139 c	289.0 ab	17.80 c
9	90L19	L19	4294 d	291.9 a	14.72 d
10	WC90134A	L19	5449 bc	247.0 e	22.08 ab
11	90S1	EL Elite COM	4094 d	263.3 cd	15.44 d
	mean		5454	269.2	20.33
	lsd (0.05)		598	12.9	2.06
	cv		9.45	4.13	8.73

	Variety	Description	Sucr%	CJP%
1	MHI E4	MHI E4	17.80 d	94.41 a
2	ACH 185	ACH 185	19.14 b	93.83 ab
3	WC91266	H23CMS x L19 Select	18.24 cd	94.00 a
4	WC91267	657CMS x "	18.22 cd	94.63 a
5	WC91268	576CMS x "	18.81 bc	94.58 a
6	WC91269	BMC CMS x "	18.01 d	93.62 ab
7	WC91270	FC607CMS x "	18.34 cd	94.25 a
8	WC91270M	88S9-02 x "	19.95 a	93.74 ab
9	90L19	L19	20.19 a	93.62 ab
10	WC90134A	L19	17.12 e	94.02 a
11	S90S1	EL Elite COM	18.70 bc	92.62 b
	mean		18.59	93.94
	lsd (0.05)		0.57	1.14
	cv		2.67	1.05

* Duncan's Multiple Range Test - Means with same letter suffix are not significantly different at the 0.05 level.

POTENTIAL BIOCONTROL OF RHIZOCTONIA ROOT ROT

J. C. Theurer and J. M. Halloin

The Rhizoctonia disease nursery at East Lansing has been planted on the same tract of soil for several years. In alternate years, half of the field was used for disease evaluation and the other half was seeded to alfalfa in an effort to maintain a good population of Rhizoctonia solani (AG 2-2) in the soil. Additionally, diseased roots were left on top of the soil to desiccate during the winter, and the residual was ploughed under in the spring. Rhizoctonia in the soil was not entirely relied upon for establishing a good

infection. Each year the plots were also artificially inoculated by dispensing Rhizoctonia-infected ground millet into the crowns of the sugarbeet plants. In 1990 and 1991, it was observed that there did not appear to be as severe an infection overall as was observed in previous years. The hypothesis was made that this might be due to the increase of microorganisms that were antagonistic to Rhizoctonia. An experiment was set up in 1992 in an effort to test this hypothesis.

Twelve genotypes varying in Rhizoctonia resistance from highly susceptible to highly resistant were selected for comparison of disease infection, when grown on land in the regular disease nursery (L1) versus land outside the nursery (L2), which had never been used for Rhizoctonia evaluations. Six replications of the 12 entries were planted in the Rhizoctonia disease nursery in single row plots 28 inches apart and 25 feet long. A similar planting using the same randomization was made on land about 1000 yards from the disease nursery. Special effort was made to standardize the treatments. Land was fertilized at the same recommended rate of 90 lb. N/acre plus adequate phosphate and potassium as determined by soil test. The plantings were made with the same drill on the same day, beets were thinned the same day and otherwise treated similarly. After thinning, a stand count was taken of the number of beets in each plot. When the beets were at the 10-12 leaf stage, they were inoculated on the same day with the same batch of inoculum and at the same rate. The beets were dug November 21 amd 22, and each beet was scored for Rhizoctonia on a 0 to 4 scale where 0 = nonevident disease symptoms and 4 = greater than 25% of the root and crown rotted. The average score and the percentage of diseased beets was calculated for each genotype.

RESULTS AND DISCUSSION

By August, there were significant visual differences in the disease incidence of the two plantings. The L2 planting had far more foliar disease symptoms than were observed in the L1 planting and several genotypes in L2 had more dead plants. The average disease scores and the percentage of disease for each genotype is shown in Table 11. When the beets were dug in November, genotypes in the L2 planting had an average score of 3.05 versus 2.47 for the L1 planting, and the percentage of diseased plants was 14.58% higher in L2. The ANOVA indicated there were significant genotype x location interactions. All of the 12 genotypes had higher disease scores and indices at the L2 location than in the usual disease nursery (L1) and for seven of the 12 (3, 4, 5, 6, 7, 9, and 11) including the resistant check FC 701/5, the differences were statistically ($p=0.05$) significant. These results support the hypothesis that there may be a buildup of beneficial organisms in the soil of the Rhizoctonia disease nursery (L1) that offer some measure of biocontrol for this disease. We plan to repeat the experiment in 1993 in an attempt to further substantiate these findings. Confirmation will suggest the use of an alternate site for Rhizoctonia root and crown rot evaluations of breeding material. Biocontrol studies could be investigated using the L1 land.

Table 11. Rhizoctonia root rot mean scores and % diseased plants or 12 genotypes grown on land used repeatedly for many years as a Rhizoctonia disease nursery versus grown on land not previously used for Rhizoctonia disease evaluation.

	Genotype	Root Rot Score		%Diseased plants	
		In Nursery	Outside	In Nursery	Outside
1.	US H23 (Susc.)	2.69 cde*	3.10 bc	67.28 cde	77.60 bc
2.	86B18-30	3.51 ab	3.86 a	87.64 ab	96.48 a
3.	88B12	2.76 cde	3.77 a	69.01 cde	94.17 a
4.	87B3--26	2.86 cd	3.58 a	71.39 cd	89.35 a
5.	86B18-12	2.69 cde	3.71 a	67.13 cde	92.68 a
6.	88B22	2.52 def	3.11 bc	63.10 def	77.78 bc
7.	87B3-33	2.20 fg	2.94 cd	55.00 fg	73.52 cd
8.	85250-80	2.35 efg	2.74 cde	58.75 efg	68.48 cde
9.	85320-0	2.21 fg	2.83 cd	55.19 fg	70.63 cd
10.	86B18-1	2.00 gh	2.01 gh	50.02 gh	50.33 a
11.	FC 701/5	2.08 fgh	2.88 cd	52.08 fgh	71.90 cd
12.	FC 712 (Res.)	1.71 h	2.06 gh	42.83 h	51.55 gh
LOCATION:					
MEAN		2.47	3.05	61.62	76.20
LSD 0.05		0.50	0.28	12.58	7.10
EXPERIMENT:					
MEAN		2.76		68.91	
LSD 0.05		0.14		10.11	
C.V.		12.79		12.83	

* Duncan's Multiple Range Test - Means with same suffix letters are not significantly different at the 0.05 level.

RHIZOCTONIA ROOT ROT EVALUATION FOR COMMERCIAL AND EXPERIMENTAL HYBRIDS AT EAST LANSING, MI. 1992

J. C. Theurer, Lee Hubble and J. H. Halloin

Fifteen hybrid varieties plus the resistant check, FC 701/5, and two susceptible checks, USH 23, and Univers were evaluated for their resistance to Rhizoctonia root rot in the disease nursery maintained at E. Lansing, MI. The natural source of inoculum in the soil was supplemented with an application of ground millet infected R. solani, which was applied to the crowns of the beets just prior to layby. The roots were dug by hand in early November and scored for disease on a scale of 0 = no infection lesions to 4 = dead plant. There was a relatively good infection in the nursery this year. Univers was the most susceptible variety and the resistant check, FC 701/5, was the most resistant entry in the test. Most varieties were moderately susceptible to Rhizoctonia and there

was little significance between their disease scores or the percent of diseased plants. ACH86-1350, ACH86-1353, Beta 5639, and ACH207 had the most resistance. These varieties were not significantly different in resistance than the resistant check variety FC 701/5.

Table 12. 1992 Commercial Variety Rhizoctonia Evaluation, USDA Disease Nursery. East Lansing, MI.

		RZ Score	% Diseased Plants
1.	ACH 89-220	3.21 a*	80.33 a
2.	ACH 207	2.83 abcd	70.76 abcd
3.	ACH 197	2.95 abc	73.85 abc
4.	ACH 185	3.22 a	80.51 a
5.	SX 1101	3.12 abc	78.05 abc
6.	SX 1103	3.13 ab	78.25 ab
7.	MHI E4	3.02 abc	75.53 abc
8.	MHI E9	3.00 abc	74.89 abc
9.	MHI E10	3.17 ab	79.35 ab
10.	BETA 5315	3.00 abc	75.08 abc
11.	BETA 5931	3.17 ab	79.23 ab
12.	BETA 5639	2.74 abcd	68.43 abcd
13.	BETA 5603	2.97 abc	74.24 abc
14.	ACH86-1353	2.45 cd	61.23 cd
15.	ACH86-1350	2.51 bcd	62.76 bcd
16.	UNIVERS	3.35 a	83.64 a
17.	US H23 (Susc. Check)	3.06 abc	76.49 abc
18.	FC 701/5 (Res. Check)	2.27 d	56.67 d
MEAN		2.95	73.85
lsd 0.05		0.57	14.20
C.V.		13.55	13.55

* Duncans Multiple Range Test - Means with same letter are not significant at the 0.05 level.

SUGARBEET RESEARCH

1992 Report

Section F

University of Idaho
Idaho

Dr. S. L. Hafez
Dr. A. J. Anderson
Dr. J. J. Gallian

The research was supported in part by funds provided through the University of Idaho and the Beet Sugar Development Foundation.

CONTENTS

BEET SUGAR DEVELOPMENT FOUNDATION

Progress Report 1992

Project #300

University of Idaho

Saad L. Hafez

Progress Report
Project #300

Non-chemical means to reduce the sugarbeet cyst nematode population and minimizing yield losses

Saad L. Hafez

The sugarbeet nematode can dramatically affect the growth and development of the sugarbeet plant. Severe nematode infestations have reduced root yields as much as 70 percent. It is a common practice for sugarbeet growers to spend $80 to $200 per acre for nematicides to control the pest. The availability of two of the most commonly used nematicides, Telone II and Temik, is in question since both compounds are presently under review by the Environmental Protection Agency and have come under attack recently by several environmental groups.

Trap crops of oil radish and yellow mustard have been developed for control of the sugarbeet nematode. Trap crops are usually planted after small grain harvest in the summer and are allowed to grow until winter temperatures kill the crop. Growing trap crop in nematode-infested soils triggers the nematode eggs to hatch. The nematode larvae enter the trap crop root but are not able to reproduce. The nematode population density in the soil is reduced and conditions are again favorable for sugarbeet production.

Oil radish var. (Pegletta) and Buckwheat var. (Prego) were planted in the fall of 1991, following wheat, in sugarbeet fields heavily infested with SCN in the Dry Lake area of Idaho. Soil samples for nematode analysis were collected before planting the cover crops, after discing and before planting sugarbeet. Nematode were extracted by the sugar flotation-centrifugation technique. Results (Table 1) showed that Pegletta and Prego reduced the SCN egg population by 78 and 18% from the initial population. In the following spring (1992) field was planted to sugarbeet and Temik was applied at planting on part of the oil radish and buckwheat plots. Root yield was measured and results showed (Table 2) no significant yield differences between oil radish, buckwheat or Vapam (standard nematicide treatment). Also, there was no significant difference between the use of Temik and non-use of Temik on either crop.

In a different study, two nematode resistant oil radish varieties (Pegletta and Nemex) and yellow mustard var. (Maxi) were planted in the spring of 1991 in sugarbeet fields heavily infested with SCN at Parma. Each variety was replicated five times in complete randomized strip design.) Results (Table 1) indicated that Pegletta, Nemex and Maxi significantly reduced the number of SCN eggs by 67, 23 and 87% of the initial population respectively. The control treatment, fallow, reduced egg population by 28% of the initial population.

Results of both studies indicated that resistant catch crops should be used as a part of integrated systems. Also, different varieties of catch crops has different levels of resistance (none of them are absolute).

Important conditions to increase the effectiveness of nematode-resistant catch crops on reducing S.B.C.N. nematode populations:

1. Dense planting and deep root penetration
2. Create optimum conditions for egg hatching (temperature and moisture)
3. High resistant levels in the varieties

In a greenhouse test several varieties of oil radish, mustard and buckwheat were evaluated for their effect on sugarbeet cyst nematode population. Results in Table 4 indicated that some oil radish, mustard and buckwheat significantly reduced the cyst nematode population in comparison with the no plant treatment.

Table 1. The effect of fall planting of oil radish (Pegletta) and buckwheat (Prego) on sugarbeet cyst nematode population. Dry Lake, ID. 191, Saad L. Hafez.

Crops	- - - Nematode Population in 500 cc soil - - - Before Planting 8/12/91		After Planting 12/4/91		% Reduction
	V.C.*	Total E&L**	V.C.	Total E&L	
Oil Radish (Pegletta)	4.2	510.8	2.0	114.0	77.7
Buckwheat (Prego)	16.0	2,121.6	12.7	1,739.9	18.0

*V.C. = Viable Cyst
**E&L = Eggs and larvae
Planting date: 8/08/91
Plowing date: 10/17/91

Table 2. The effect of fall planting of oil radish (Pegletta) and buckwheat (Prego) on sugarbeet root yield and percent sugar.

	Treatments	Sugarbeet Root T/A	% of Sugar
1.	Oil Radish Fall 91	44.7 a	16.41
2.	Oil Radish Fall 91 35 lbs Temik AP	47.3 a	16.60
3.	Buckwheat Fall 91	46.0 a	16.50
4.	Buckwheat Fall 91 35 lbs Temik AP	44.7 a	15.90
5.	Vapam Fall 91	46.0 a	16.29

Means followed with the same letter are not significantly different.

mb1452

Table 3. The effect of spring planting of oil radish and white mustard on sugarbeet cyst nematode population. Parma, ID 1991, Saad L. Hafez

Crops	Nematode Population in 500 cc soil									% Reduction
	Pre-Planting 3/24/91			Post Planting 06/04/91			07/15/91			
	V.C.*	E&L/ cyst	Total E&L	V.C.	E&L/ cyst	Total E&L	V.C.	E&L/ cyst	Total E&L	
Pegletta	18.0	178	3,204	12.2	108	1,318	8.0	134	1,072	66.5
Nemex	12.0	132	1,584	9.8	110	1,078	9.6	127	1,219	23.0
Maxi	8.0	168	1,344	11.0	111	1,221	1.6	108	173	87.1
No Plant	17.6	176	3,086	20.6	146	3,008	12.2	174	2,223	28.0

*V.C. = Viable Cyst
Planting date: 3/29/91
Plowing date: 7/16/91

Table 4. The effect of different oil radish varieties on sugarbeet cyst nematode population.

Variety	Viable Cyst	Total # of E & L
Fortissimo	3.6	608
PBLO	4.0	779
Nemex	4.4	584
Lentus	4.6	453
Ultimo	5.4	743
Pegletta	6.8	828
PBLO 6	6.6	1,067
Stamm	11.0	1,689
K750	14.6	2,575
Angelia	15.4	2,619
Maxi	16.5	2,622
Siletina	79.6	12,859
Siletta Nova	127.2	26,642
Control (No plant)	28.8	4,783

Total No. of eggs and larvae -- 8,052 nematodes
Used 500 cc soil/pot
10 rep -- 15 treatments
Planted 7/11/90 Harvested 9/5/90

mb1452

Progress Report
Project # 301

Controlling the Sugarbeet Cyst Nematode in Tare Dirt

Returning tare dirt back to the field is the major means of nematode spread and reinfestation. Tare dirt should never be spread on the field because it can be a primary source of nematode infestation. Close to one half million tons of tare dirt is collected annually from the total sugarbeet acreage for Amalgamated Sugar Company only. This dirt is a good top soil, high in organic matter and nutrients, and it can be used if we can economically control the nematodes present in it.

In this project we propose to investigate the means to control nematodes present in tare dirt and determine if tare dirt can be utilized without the risk of infesting new ground with nematode.

Accomplishments:

The effect of sugarbeet tare dirt composting process on the viability of sugarbeet cyst nematode *Heterodera schachtii*.

The objective of this study was to control sugarbeet cyst nematode in the tare dirt through the composting process and thereby reduce the chances of its spread. During the composting process, organic matter breaks down and releases considerable heat (60°C) and high concentrations of CO_2 and other toxic gases which can be lethal to nematodes. Composting also enhances the activity of other nematode-destroying organisms such as bacteria and fungi which may parasitize nematode eggs and juveniles. Two experiments were conducted over two years during the fall of 1990 to spring of 1991 and fall 1991 to spring 1992. In the first experiment, wooden boxes (inside dimensions of 4' x 4' x 8') with bottoms were filled with tare dirt infested with high populations of cyst nematodes. Boxes were arranged in two rows 4 feet apart and replicated six times. Boxes were covered in fall and winter by black plastic for protection from snow and rain. In the second

experiment, nematode infested tare dirt was collected at harvest time and piled in two 8' x 20' x 200' piles next to sugarbeet receiving station in Parma, Idaho. Tare dirt samples were taken from boxes and open piles before composting and five months later to determine nematode populations. Tare dirt was thoroughly mixed, and a 5000-ml subsample was processed by a wet sieve method. Nematodes were extracted by the sugar flotation-centrifugation technique. The results indicate that under close system (boxes) no stages of the sugarbeet cyst nematode survived the composting process (Table 1). Under open piling system only 2% of the nematode were able to survive the composting process (Table 2).

To determine the nutritional value of composted tare dirt sample were analyzed for NPK value and the result showing in (Table 3).

Conclusions:

No stages of sugarbeet cyst nematode survived the composting process in redwood boxes. Composting sugarbeet tare dirt in open field piles will kill more than 98% of sugarbeet cyst nematode. Sugarbeet tare dirt can be used as a soil amendment or potting mix after composting.

mb1139

Table 1. **The effect of sugarbeet tare dirt composting on sugarbeet cyst nematode populations. Parma, ID 1990-91. (Boxes)**

	Nematode population in 500 cc tare dirt					
	Before composting			After composting		
	11/1/90			4/5/91		
Treatments	V.C.	Total eggs	Total Juv.	V.C.	Total eggs	Total Juv.
1	83*	17,813	1,608	0	0	0
2	113	22,850	2,822	0	0	0
3	118	22,317	2,737	0	0	0
4	134	26,439	3,348	0	0	0

* Average of six replicates

Table 2. **The effect of sugarbeet tare dirt composting on sugarbeet cyst nematode populations. Parma, ID. 1991-92.**

	Nematode populations in 500 cc tare dirt			
Sampling date	V.C.	Eggs/cyst	Juvenile/cyst	Total
12/26/91	29.8 A	73.0 A	19.5 A	2679.8 A
2/28/92	3.5 B	27.0 B	12.7 A	225.7 B
3/09/92*	0.7 B	4.0 C	3.7 B	10.2 B
5/26/92	1.3 B	10.0 C	4.1 B	41.2 B

Treatments followed by the same letter are not significantly ($P < 0.05$) different according to Duncan's Multiple Range Test.

* Tare dirt piles was turned over on that date.

Table 3. **Tare Dirt Nutritional Value as Soil Amendment**

Nitrate	65 ppm
Phosphorus	41 ppm
Potassium	401 ppm
pH	8.8
Organic matter	2.5

Sugar Beet Foundation Report

Report 1992 Biocontrol of Sugar Beet Disease

Anne J. Anderson, Utah State University, Logan, UT 84322-5305

The rotation of sugar beet with wheat raises the question of whether the interactions of these crops with soil microbes influence the disease state in beet. We have already demonstrated that fluorescent pseudomonads from sugar beet roots have biocontrol potential for two sugar beet pathogens *Phoma betae* and *Rhizotonia solani*. In this report we discuss the inhibitory properties of fluorescent pseudomonads from wheat roots.

A high proportion of pseudomonads from two classes of wheat roots are brown, brown-green or green-yellow pigmented, indicating that they are likely to produce phenazines. Consequently, they resemble the group of fluorescent pseudomonads we isolated from 1-month-old sugar beet roots which produce phenazine 1- carboxylic acid. These phenazine-producing, sugar beet isolates are strong antagonists of the growth of *Phoma betae* and *Rhizotonia soloni* on plate medium. They also suppress disease in seedlings caused by these pathogens. Consequently we were intrigued to see whether the wheat - rhizosphere organisms also were inhibitory to beet pathogens.

Ten wheat-associated pseudomonads were selected which showed variation in the color of the phenazine-product they produce (Table 1). Most of the isolates were strongly inhibitory to the growth of *Phoma betae* on potato dextrose agar. Only a subset of the isolates inhibited *Rhizotonia solani*. One of the isolates (2E-3) displaying differential inhibition was identified as producing phenazine 1- carboxlyic acid by TLC and spectral analysis of the pigment. This differential inhibition is more variable than with the beet isolates which were more nearly equally inhibitory to the pathogens. Thus the mechanism(s)

of growth inhibition are not general to all fungi.

Table 1
Inhibition of growth of *Phoma betae* and *Rhizoctonia solani*

Pseudomonad isolate and color	Inhibition of pathogen: *R. solani*	*P. betae*
1E-11 brown	-	+++
1E-22 brown/yellow	-	+++
2E-1 brown	+	+++
2E-5 brown/orange	-	++
2E-8 green/yellow	++	+++
PCS brown	-	-
1E-2 brown	-	++
2E-3 green/yellow	-	++
1E-20 green/yellow	+	+++
2E-21 green/yellow	+	++

Inhibition was scored on PDA plates after 5 days of incubation at 26° C.

The inhibition scale ranges from - for no inhibition to +++ for strong inhibition.

We also examined inhibition of two other fungal pathogens associated with beet seed - a Fusarium species and an Alternaria species, identified as *Alternaria tenuissimum*. Only one of the phenazine - producing isolates, which was a strong inhibitor of *Rhizotonia solani* and *Phoma betae*, inhibited Alternaria growth (Table 2).

The Fusarium species was inhibited by several of the pseudomonad isolated from wheat-roots (Table 2). The Fusarium species from beet seed was identified as a *F. culmorum* isolate, other isolates of which are documented as wheat pathogens. The ten wheat-rhizosphere pseudomonad isolates were found by Dr. B. Kropp (USU) to be strongly

inhibitory to isolates of *F. culmorum* which were obtained from diseased wheat roots and retained pathogenicity to wheat in greenhouse trials. These findings demonstrate variability between isolates of a fungal pathogen in inhibitory potential.

Table 2

Inhibition of growth of *F. culmorum* and *Alternaria tenuissimum*.

Pseudomonad isolate and color	Inhibition of pathogen: *Fusarium*	*Alternaria*
1E-11 brown	-	–
1E-22 brown/yellow	-	–
2E-1 brown	+	–
2E-5 brown/orange	+	–
2E-8 green/yellow	+	–
PCS brown	-	–
1E-2 brown	+	–
2E-3 green/yellow	+	–
1E-20 green/yellow	+++	–
2E-21 green/yellow	+++	+++

Inhibition was scored on PDA plates after 5 days of incubation at 26°C.

The inhibition scale ranges from - for no inhibition to +++ for strong inhibition

A second group of wheat colonizing fluorescent pseudomonads were examined for their potential to inhibit the beet pathogens *P. betae* and *R. solani*. These pseudomonads are *P. syringae* isolates which exist as epiphytes when they are surface colonizes and as pathogens causing brown spot on wheat upon gaining ingress. Antagonistic properties of

these isolate corresponds to the production of two peptide toxins, syringomycin and syringopeptide. Two isolates producing these toxins gave strong inhibition of *Phoma betae* but showed no inhibition of *Rhizoctonia solani*.

Conclusions

We have demonstrated that wheat-associated pseudomonads have the potential to antagonize the growth of two, diverse-type, fungal pathogens of beet, *P. betae* and *R. solani*. Inhibition of growth is attributed to the production of phenazines by the saprophytic pseudomonads and to peptide toxins by the potentially wheat pathogenic strains of *P. syringae*.

We suggest from these findings, that microbes remaining in the debris in the soil from wheat cropping could influence the disease outcome of a subsequent sugar beet planting.

SUGARBEET RESEARCH

1992 Report

Section G

Texas Agricultural Experiment Station
Bushland, Texas

Dr. C. M. Rush
Dr. G. J. Michels

Cooperation:

Imperial Holly - Hereford, Texas

The research was supported in part by funds provided through the Texas A&M University and the Beet Sugar Development Foundation (Project 500, 502 and 520).

CONTENTS

Abstracts of Papers Published or Approved for Publication

HARVESON, R. M. and C. M. RUSH. 1992. Sugarbeet response to multiple soilborne pathogens. 1992 APS Annual Meeting, Portland, OR, August 8-12, 1992.

The test was conducted on a clay loam naturally infested with four soilborne pathogens: beet necrotic yellow vein virus (BNYVV), *Rhizoctonia solani* (AG2-2), *Aphanomyces cochlioides*, and *Fusarium oxysporum f. sp. betae*. Twenty sugar beet entries (15 hybrids, 5 parental lines) were planted in a randomized, split plot design with six replications. Half the test was fumigated and half left untreated. Each plot was evaluated twice during the season by ELISA for BNYVV infection. A rating was made at midseason based on stand and foliar symptoms of root rot. At harvest, a rhizomania rating and root rot index were taken and analyzed with yield data. Fumigation had no effect on virus incidence or sugar percentage, but some entries showed improvement in root yield and lower disease ratings. Inverse correlations were observed between disease ratings at harvest and percent sugar and between midseason disease ratings and root yield in tons/acre.

RUSH, C. M. 1992. Stand establishment of sugar beet seedlings in pathogen-infested soils as influenced by cultivar and seed-priming technique. *Plant Dis*. 76:800-805.

A greenhouse study was conducted to determine whether selected sugar beet (*Beta vulgaris*) cultivars responded differently to various seed-priming techniques. Priming techniques included osmopriming with -1.5 MPa NaC1 or -1.2 MPa polyethylene glycol (PEG 8000) and solid matrix priming with water and a hydrous silicate clay mineral as the solid substrate. Washed and nontreated seed were used as controls. Treated seed of cultivars Ach146, Ach177, HH42, and Tx9 was planted in a silt loam-peat soil mix artificially infested with *Aphanomyces cochlioides* or *Pythium ultimum*, or in noninfested soil. Seedling emergence and damping-off were recorded daily. Although varying in degree, all cultivars responded similarly to the different seed treatments. There was typically no seed treatment x cultivar interaction with any of the recorded variables at any time. All priming treatments increased the rate and uniformity of seedling emergence and also reduced the incidence of preemergence damping-off in soils infested with *P. ultimum*. There was a small but significant positive correlation between T_{50} (the weighted mean time for emergence of all seedlings) and preemergence damping-off ($R^2 = .23$, $P \leq 0.05$). As T_{50} increased (slower emergence), preemergence damping-off increased. *P. ultimum* caused both preemergence and postemergence damping-off; however, *A. cochlioides* caused only postemergence damping-off. Although priming treatments reduced preemergence damping-off, no treatment significantly reduced postemergence damping-off.

RUSH, C. M. and D. E. CARLING. 1992. Frequency and virulence of *Rhizoctonia solani* anastomosis groups isolated from wheat and sugar beet in Texas. 1992 APS Annual Meeting, Portland, OR, August 8-12, 1992.

Rhizoctonia solani causes disease of wheat and sugar beet in Texas. The anastomosis group (AG) of 46 isolates from sugar beet, 45 from wheat, and an additional 7 from beet seedlings was determined. Eighty-nine percent of the mature beet isolates were AG2-2, 95% of the wheat isolates were AG4, and the isolates obtained from beet seedlings were predominantly AG4 or AG5. Two binucleate isolates were recovered. Selected isolates were used in additional studies. All were capable of saprophytically colonizing wheat, corn, cotton, and sorghum residue and grew best *in vitro* between 25-30C. In pathogenicity studies, only AG2-2 and AG4 isolates reduced emergence or caused postemergence damping off of wheat or sugar beet seedlings. The AG4 isolates from wheat were especially virulent on sugar beet seedlings.

RUSH, C. M. and K. M. VAUGHN. 1992. Effect of irrigation, soil matric potential, and seed priming on sugar beet seed germination and damping-off caused by *Aphanomyces cochlioides*. *Phytopathology* 83:202-206.

Laboratory studies were conducted to evaluate how seed priming and soil matric potential affect sugar beet seed germination. Seed treatments included solid matrix priming (SMP), SMP + hydroxyethyl cellulose (HEC) hydrated to form a viscous fluid, and an untreated control. Seed were planted in soils with matric potentials ranging from -100 to -700 J kg^{-1}. Evaluations of seed germination and radicle length were made at 2, 3, 4, 5, and 7 days after planting. Soil matric potential had only minimal effect on seed germination and radicle elongation as determined by regression analysis for individual treatments and times after planting. Conversely, seed treatments greatly influenced germination. There was no significant seed treatment x matric potential interaction. At 2 days after planting, seed germination, averaged across all matric potential treatments, was 72, 34, and 1% for the SMP + HEC, SMP, and control treatments, respectively. Mean radicle lengths for the same treatments were 3.3, 1.2, and 0.1 mm. By day 7, differences in germination among seed treatments were minimal, but significant differences in radicle length were found. These same seed treatments were used in a greenhouse study to determine how irrigation affected Aphanomyces seedling disease. Seed of each treatment were planted in soil, contained in 10 wooden boxes (1- x 2-m), that was artificially infested with oospores of *Aphanomyces cochlioides*. All boxes were flood-irrigated approximately 10 days before planting; after planting, five of the boxes were irrigated again. Soil water content, seedling emergence, and seedling damping-off were monitored for 3 wk. Seedlings from SMP and SMP + HEC seed treatments emerged significantly earlier than untreated seed, but no seed treatment affected seedling disease. However, irrigation treatment greatly affected disease incidence. In the five boxes that received postplant irrigation, mean seedling disease, averaged across all seed treatments, was 41%, but in the five boxes that received only a

preplant irrigation, mean disease incidence was significantly lower, at 7%. Analysis of soil dry-down curves from the two irrigation treatments revealed that soil that received only a preplant irrigation was too dry 5 days after planting for zoospore movement. These results indicate Aphanomyces seedling disease can be significantly reduced by planting into soil wet enough for seed germination but too dry to zoospore movement.

RUSH, C. M. and K. VAUGHN. 1992. Seed quality effects on emergence and yield of hard red winter wheat. 1992 APS Annual Meeting, Portland, OR, August 8-12, 1992.

A three-year study was conducted to determine whether wheat seed quality affected seedling emergence and yield. Grain was collected from growers' fields and sorted into four categories (very good, good, bad, and very bad) based on seed weight. Seed were planted in randomized field plots, stand counts taken, and at harvest, total yield and test weight were determined. No field x quality interaction existed for stand, yield, or test weight any year of this study. Mean 100 seed weights for the four categories over three years, 3.60, 2.87, 2.27,and 1.44 g, were all significantly different. Despite large differences between categories, seed quality had minimal effect on any measured variable in 1989 or 1991. However, in 1990, seed from the very good and good categories produced better stands and higher yields than very bad seed. Planting date appeared to be associated with stand establishment and poor seed did better when planted in October than November.

Papers Published Since Abstracted in Previous Report

RUSH, C. M. 1992. Stand establishment of sugar beet seedlings in pathogen-infested soils as influenced by cultivar and seed-priming technique. *Plant Dis.* 76:800-805.

RUSH, C. M. 1992. Effect of irrigation, soil matric potential, and seed priming on sugar beet seed germination and damping-off caused by *Aphanomyces cochlioides*. *Phytopathology* 83:202-206.

BIOLOGICAL CONTROL OF SUGAR BEET SEEDLING DISEASE
BSDF Project 502

INTEGRATION OF BIOCONTROL AGENTS WITH SOLID MATRIX PRIMING OF SUGAR BEET SEED TO REDUCE SEEDLING DAMPING-OFF

Kathy M. Vaughn and Charles M. Rush

Introduction

Biological control is a promising approach for seedling disease reduction and can be used in combination with other systems. For advancement of biocontrol technology, improved methods of preparation and application of antagonistic microorganisms are necessary.

Solid matrix priming (SMP) is a physiological seed treatment of controlled hydration in which germination is initiated but stopped before radicle emergence. SMP increases stand establishment, disease resistance, and seedling vigor.

Little research has been done concerning the integration of biocontrol agents with solid matrix priming to control soilborne pathogens. In 1989, Harman and Taylor tested different bacterial strains and their interaction with solid matrix priming seed treatment on a range of crops and pathogens. Results indicated potential to improve biological seed treatments by combining effective biocontrol agents and solid matrix priming. However, little or no work has been done with sugar beets.

Research Objectives

1. Determine if stand establishment of solid matrix primed (SMP) seed, planted in pathogen-infested soils, can be enhanced by the addition of biocontrol agents.

2. Determine whether the efficacy of biocontrol agents can be enhanced when integrated with solid matrix priming.

3. Determine if time of application of biocontrol agents with solid matrix priming affects efficacy of disease control.

Materials and Methods

Pathogens. Pathogens tested were *Rhizoctonia solani* Kühn isolate R26, anastomosis group AG-4, and *Pythium aphanidermatum* (Edson) Fitzp. isolate P13 were used in these studies. R26 was stored on barley, and P13 oospores, produced using oatmeal slants, were stored in soil. Both pathogens were isolated from diseased sugar beets and were highly virulent.

Biocontrol Agents. After preliminary screening a number of biocontrol organisms, *Pseudomonas cepacia* Burkholder and *Gliocladium virens* Miller et al. were selected for their antagonism against P13 and R26. Reports have shown *P. cepacia* to be effective in controlling *Pythium* damping-off and *Aphanomyces* root rot of peas. Also, *G. virens* has been reported to suppress *Rhizoctonia* and *Pythium* damping-off of cotton seedlings.

Bacterial isolate *Pseudomonas cepacia*, strain AMMD obtained from J. L. Parke, was grown in nutrient broth yeast extract (NBY) shake culture at room temperature. After 48 hours, NBY agar plates were inoculated with 2.5 ml suspension and incubated for 24 hours at room temperature. Bacteria from NBY agar plates was used to inoculate sugar beet seed.

Fungal isolate *G. virens*, strain Cr-4 obtained from C. R. Howell, was grown on potato dextrose agar with streptomycin and rifampicin (PDA++) for 3 to 7 days under light. Conidia was used to inoculate sugar beet seed.

Seed Treatments. Different carriers may be used in solid matrix priming. Our priming method consisted of mixing a dry, hydrous, silicate clay with DI water and sugar beet seed 1:1:1 (w/v/w). Seed in the mixture was hydrated 2 days at 25 C, allowed to dry down over a 3-day period, and then separated from solid matrix by sieving.

Sugar beet seed cultivar ACH-177 was used in the experiment. There were three different sequences when biocontrol agents were integrated with SMP:

1) BEFORE (Inoculate/Dry/Prime) - seed was inoculated with biocontrol agents, allowed to dry for 2 days, then primed.

2) DURING (Inoculate/Prime) - seed was inoculated and the SMP process started immediately.

3) AFTER (Prime/Inoculate) - seed was primed then inoculated with biocontrol agents.

These three sequences of applying AMMD or Cr-4 with solid matrix priming represent six seed treatments. Nonprimed seed was also inoculated with biocontrol agents, and nonprimed and SMP seed, not inoculated, were used as controls, for a total of ten seed treatments.

Soil Treatments and Planting Procedures. The soil mixture consisted of pasteurized field soil and sand (1:1 ratio). About 500 oospores of P13 per gram of soil were used to infest soil. Two barley kernels colonized with R26 were used to infest soil mix in each pot. Seeds were planted in soils infested with *Pythium*, *Rhizoctonia*, and noninfested soils contained in 3.5-inch plastic pots.

Ten seeds were planted per pot, with 6 replications of each seed treatment-soil treatment combination, for a total of 180 pots. Pots were placed in saucers, and soil was subirrigated. These were divided between two growth chambers, and the experimental design was a

randomized complete block. The experiment was conducted at 25 C with continuous light. The duration of the study was 3 weeks.

Data Acquisition and Analysis. Seedling emergence and damping-off were recorded. Postemergence damping-off was based on number of seed emerged, not number of seed planted, and final stand was based on number of seed planted. Data were analyzed using GLM, and treatment means were separated using Duncan's multiple range test.

Results

Performance of Seed Treatments in Noninfested Soil. In noninfested soil, nonprimed seed treated with Cr-4 had significantly less maximum emergence than all other seed treatments, with 90% emergence. Apparently, Cr-4 was slightly phytotoxic to nonprimed seed planted in noninfested soil. However, the problem was overcome when Cr-4 was combined with SMP, with 97% maximum emergence. No other seed treatment caused any phytotoxicity. As in previous studies, all treatments with primed seed emerged earlier than nonprimed seed (data not shown).

Affects of Sequence of Biocontrol Agents Integrated with Solid Matrix Priming. Sequence of biocontrol agent Cr-4 integrated with SMP did not affect damping-off or final stand when seed was planted in soils infested with R26, P13, or noninfested soil. However, an interaction occurred between sequence of AMMD application and solid matrix priming with regard to preemergence damping-off, postemergence damping-off, and final stand in soil infested with P13 (Table 1). There was no difference concerning preemergence damping-off between seed treatments when AMMD was applied during or after SMP, however, when AMMD was added before the priming process, there was significantly more preemergence damping-off.

No postemergence damping-off occurred in soil infested with P13 when AMMD was added during priming (Table 1). Also, postemergence damping-off was significantly less when AMMD was added after priming than adding AMMD before priming.

In soil infested with P13, final stand was significantly greater when AMMD was added during priming, followed by adding the biocontrol agent after priming (Table 1). Final stand was significantly less when AMMD was added before the priming process.

Performance of Seed Treatments in Soil Infested with *P. aphanidermatum*. The sequence of AMMD application before solid matrix priming did not perform well in soil infested with P13, therefore, the sequence was omitted and not included in this analysis. Primed seed, with or without the addition of biocontrol agents, had significantly less preemergence damping-off than all nonprimed seed treatments (Table 2). The highest level of preemergence damping-off occurred with the nonprimed AMMD seed treatment.

Table 1. Sequence of AMMD application with SMP in soil infested with P13.[a]

Sequence[b]	% Pre damp	% Max emerg	% Post damp[c]	% Final stand[d]
Before	11.6 a[e]	88.3 b	77.5 a	20.0 c
During	3.3 b	96.6 a	0.0 c	96.6 a
After	5.0 ab	95.0 ab	30.3 b	66.6 b

[a] Soil mix was infested with *Pythium aphanidermatum* (Edson) Fitzp., approximately 500 oospores/g of soil.

[b] Time when biocontrol agent AMMD was integrated with solid matrix priming.

[c] Postemergence damping-off was based on percentage of plants emerged, not number of seed planted.

[d] Final stand, approximately 30 days after planting, was based on percentage of total seed planted, not number of plants emerged.

[e] Values represent the mean of six replications of each seed treatment. Means followed by the same letter are not significantly different according to Duncan's multiple range test (P = 0.05).

SMP with AMMD or Cr-4 had significantly less postemergence damping-off than the SMP control and all nonprimed seed treatments, with the exception of nonprimed seed treated with Cr-4 (Table 2). Also, the SMP control and nonprimed seed treated with Cr-4 had significantly less postemergence damping-off than the nonprimed control and nonprimed AMMD seed treatments.

The SMP with Cr-4 seed treatment had a significantly greater final stand than the SMP control and all nonprimed seed treatments, however, it was no different than the SMP with AMMD seed treatment (Table 2). Nonprimed seed treated with Cr-4 affected final stand the same as the SMP with AMMD seed treatment. The nonprimed control and nonprimed + AMMD seed treatments had significantly less final stand than all other seed treatments.

Performance of Seed Treatments in Soil Infested with *R. solani*. In general, no seed treatment performed very well in soil infested with R26. The SMP with AMMD seed treatment had significantly less preemergence damping-off than all other seed treatments, followed by SMP with Cr-4, but still these had 32 and 59% preemergence damping-off, respectively (Table 3). All nonprimed seed treatments had high levels of preemergence damping-off.

Table 2. Performance of seed treatments in soil infested with P13.[a]

Seed treatment[b]	% Pre damp	% Max emerg	% Post damp[c]	% Final stand[d]
Nonprimed Control	21.6 b[e]	78.3 b	65.3 a	28.3 d
Nonprimed + Cr-4	16.6 b	83.3 b	25.4 bc	61.6 bc
Nonprimed + AMMD	36.6 a	63.3 c	69.1 a	20.0 d
SMP Control	1.6 c	98.3 a	42.5 b	56.6 c
SMP with Cr-4	5.0 c	95.0 a	5.9 c	89.1 a
SMP with AMMD	4.1 c	95.8 a	15.1 c	81.6 ab

[a] Soil mix was infested with *Pythium aphanidermatum* (Edson) Fitzp., approximately 500 oospores/g of soil.

[b] SMP with Cr-4 and SMP with AMMD include during and after sequences.

[c] Postemergence damping-off was based on percentage of plants emerged, not number of seed planted.

[d] Final stand, approximately 30 days after planting, was based on percentage of total seed planted, not number of plants emerged.

[e] Values represent the mean of six replications of each seed treatment. Means followed by the same letter are not significantly different according to Duncan's multiple range test (P = 0.05).

Seed treatments also had minimal affect on postemergence damping-off (Table 3). The only difference was with the SMP control which had significantly less damping-off than nonprimed seed treated with Cr-4.

The SMP with AMMD seed treatment had a significantly better final stand than all nonprimed seed treatments, but statistically was the same as SMP with Cr-4 and SMP control seed treatments (Table 3). The lowest final stand occurred with nonprimed seed treated with Cr-4.

Table 3. Performance of seed treatments in soil infested with R26.[a]

Seed treatment[b]	% Pre damp	% Max emerg	% Post damp[c]	% Final stand[d]
Nonprimed Control	78.3 ab[e]	21.6 cd	36.1 ab	11.6 bc
Nonprimed + Cr-4	86.6 a	13.3 d	70.0 a	5.0 c
Nonprimed + AMMD	75.0 ab	25.0 cd	33.3 ab	16.6 bc
SMP Control	65.0 bc	35.0 bc	21.3 b	26.6 ab
SMP with Cr-4	59.4 c	42.5 b	39.2 ab	24.2 ab
SMP with AMMD	32.5 d	67.5 a	43.5 ab	35.0 a

[a] Two barley kernels colonized with *Rhizoctonia solani* Kühn were used to infest soil mix contained in each pot.

[b] SMP with Cr-4 and SMP with AMMD include all sequences (before, during, and after).

[c] Postemergence damping-off was based on percentage of plants emerged, not number of seed planted.

[d] Final stand, approximately 30 days after planting, was based on percentage of total seed planted, not number of plants emerged.

[e] Values represent the mean of six replications of each seed treatment. Means followed by the same letter are not significantly different according to Duncan's multiple range test (P = 0.05).

Conclusions

In soil infested with *P. aphanidermatum*, stand establishment of solid matrix primed seed was enhanced by the addition of biocontrol agents AMMD or Cr-4. The efficacy of both biocontrol agents in controlling preemergence damping-off caused by P13 was enhanced when integrated with solid matrix priming, but in controlling postemergence damping-off, only the efficacy of AMMD was enhanced. However, the integration of AMMD or Cr-4 with solid matrix priming enhanced the efficacy of both biocontrol agents resulting in a greater final stand. Time of application of biocontrol agent AMMD affected efficacy of disease control when seed was planted in soil infested with P13. Final stand was significantly greater when AMMD was added during the priming process.

In soil infested with *R. solani*, preemergence damping-off of solid matrix primed seed was enhanced by the addition of AMMD. However, stand establishment was not enhanced by the addition of either biocontrol agents. The efficacy of AMMD or Cr-4 to control preemergence damping-off and achieve a greater final stand was enhanced when integrated with solid matrix priming. Time of application of biocontrol agents with solid matrix priming did not affect efficacy of disease control in soil infested with R26.

ETIOLOGY AND EPIDEMIOLOGY OF THE RHIZOMANIA DISEASE COMPLEX
BSDF Project 503

MOVEMENT OF BNYVV-INFESTED *POLYMYXA BETAE* ZOOSPORES FROM AN INOCULATED POINT SOURCE

R. M. Harveson and C. R. Rush

Polymyxa betae (Keskin) is a member of the Plasmodiophoraceae and occurs naturally in soils worldwide as an obligate parasite of several plant families. Interest in research for *P. betae* has increased in recent years due to its ability to vector beet necrotic yellow vein virus (BNYVV), the causal agent of Rhizomania.

Rhizomania was reported in Texas five to six years ago, yet it appears to behave differently than in other locations, particularly California. In Texas, Rhizomania has not spread to new areas as rapidly as in California. By the time it was detected in California, Rhizomania was so widespread it was a moot point as to how it became so widely distributed. However, in Texas we have a unique opportunity to observe the initial spread of the disease because there are still areas where Rhizomania has not been found.

By studying the epidemiology of Rhizomania, we hope to learn how it initially spreads within a field. Hopefully, this will allow us to learn how to keep Rhizomania confined to its present locations and limit further spread to new areas, both in Texas and the newly reported locations. For this reason, a 3-year field study was initiated to observe how BNYVV spreads within a field from a known point source of inoculum via irrigation and tillage.

Materials and Methods

The test was conducted at the Texas Agricultural Experiment Station in Bushland, on land which had never been cropped to sugar beets. The experiment consisted of four 30 x 100 ft. borders, each containing twelve 30-inch beds.

The first ten feet of the two outside rows of each border were planted with HH39 sugar beet seed coated with powdered sugar beet roots infested with viruliferous *P. betae* cystosori. These were the inoculum or point source regions. The remainder of the test was planted with untreated seed, and all borders were irrigated on May 14, 1992.

Four subsequent irrigation events were employed for the duration of the test. Plant samples were collected twice during the year at various points away from the point source areas and assayed by ELISA for BNYVV incidence. These sampling locations were 15, 45, 75 and 100 ft. from the point source areas in the three outside beds of each border. A sample was also

collected from the inoculated areas. Shortly before harvest, 60 soil samples, five from each row, were collected from each border. These samples were taken from the same distance intervals from the point source areas as were the plant samples. They were brought into the greenhouse, replicated once and potted and planted with sugar beet seeds. The borders were then harvested mechanically in September 1992.

Results and Discussion

In addition to the irrigations, between May and September of 1992, it rained about 18 inches at Bushland (Fig. 1). The 4-inch soil temperature was approximately 25 C at planting, and ranged between 15-30 C for the duration of the test. With the combination of warm soil temperatures and above average moisture, all environmental conditions were conducive for BNYVV infection to occur.

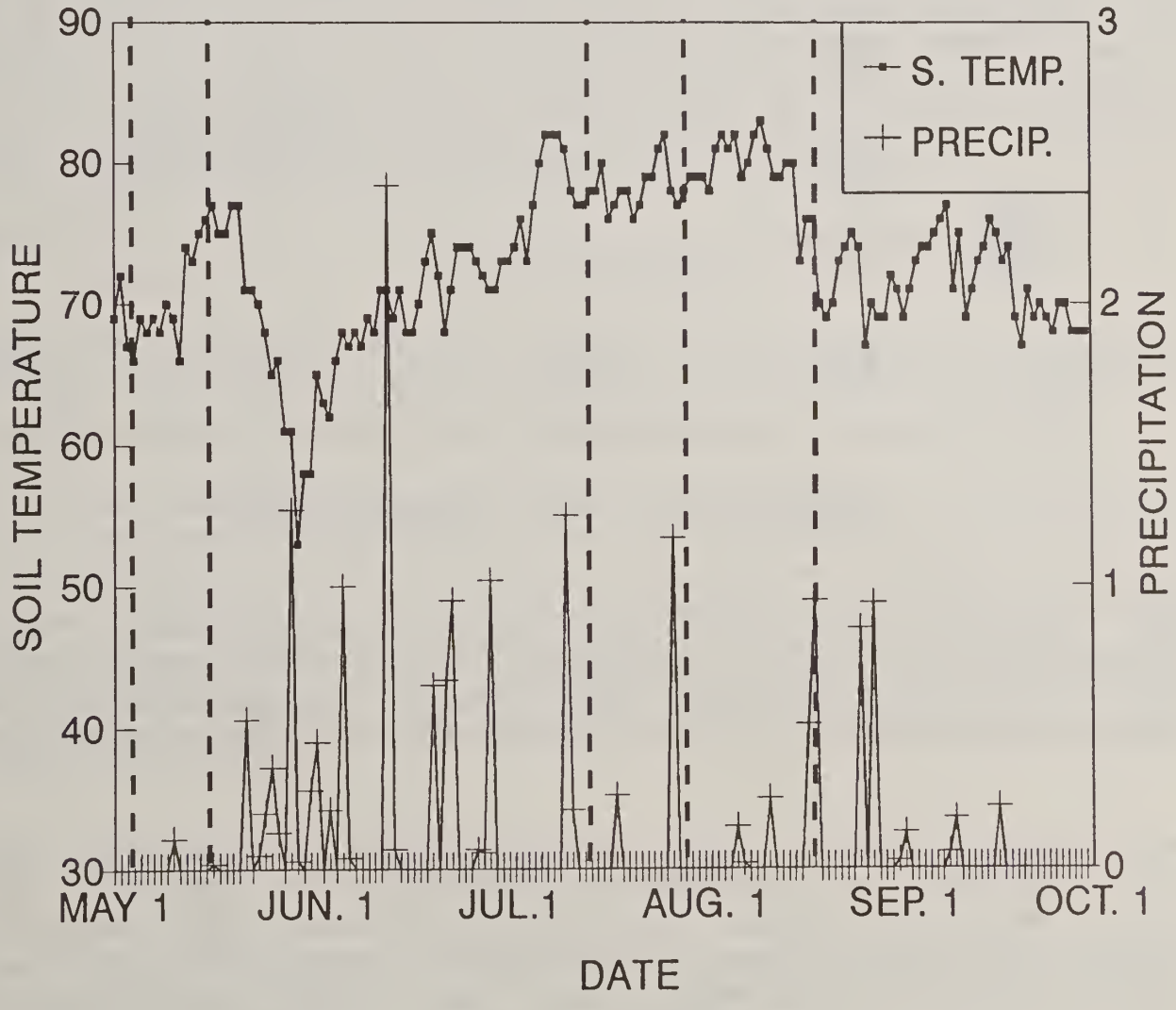

Fig. 1. Environmental data collected during 1992 epidemiology study. Vertical dashed lines represent irrigation dates. Each irrigation event applied a minimum of 3 inches of water.

The first plant samples collected and assayed showed no movement of the virus outside the inoculated areas. The second time, only one sample was infected. The plants grown in the soil samples in the greenhouse were also assayed by ELISA after a 4-month incubation period. Very few of them proved to be positive for BNYVV (Fig. 2). Only five non-point source samples were considered positive out of the possible total of 240. This indicates that very little movement of BNYVV occurred the first year due to irrigation and rainfall.

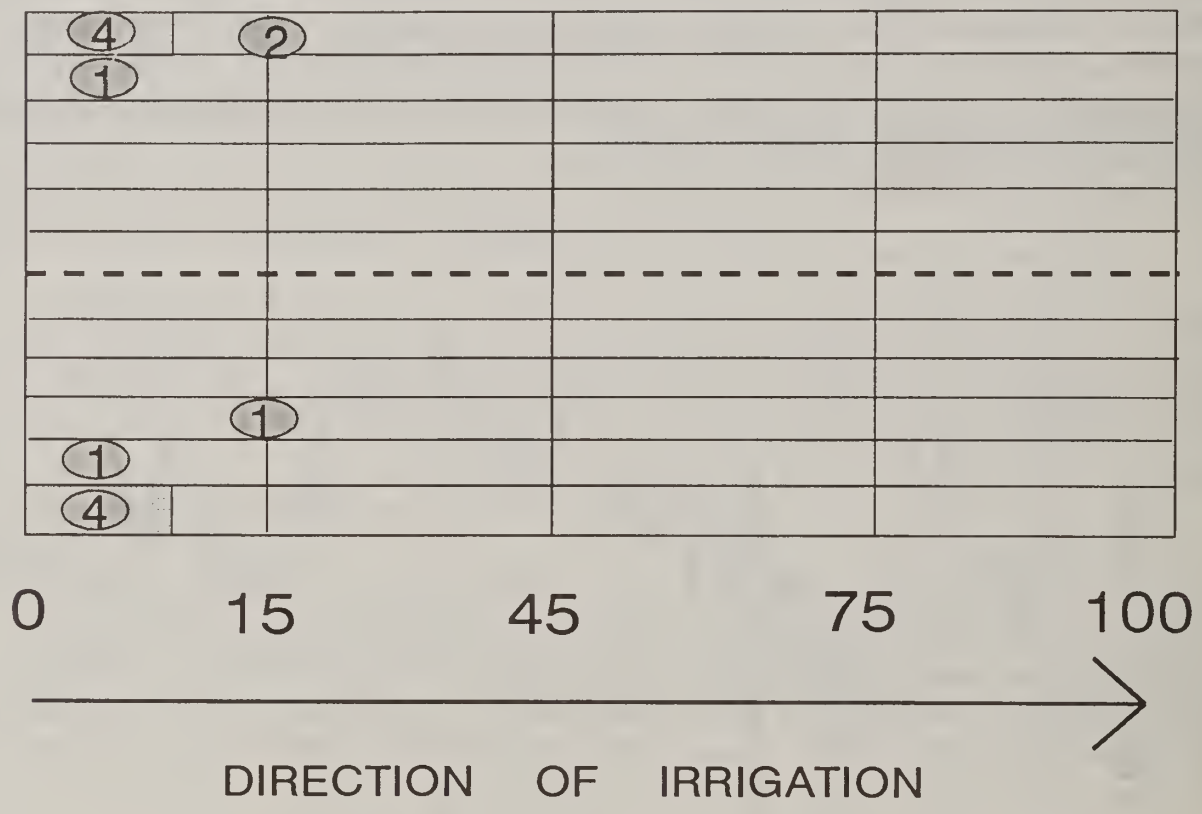

Fig. 2. Field map of one 30 x 100 ft border. Shaded boxes in two outside rows represent the inoculated point source area. Numbers depict locations sampled away from the point source for movement of viruliferous *P. betae.* Shaded ovals represent location and number of samples positive for BNYVV in all four borders after the first season of the study.

After last year's test has been disked and new beds formed, soil samples will again be collected and brought into the greenhouse in an attempt to bait out BNYVV. This will determine the extent of movement of the virus due to soil movement from both last year's mechanical harvesting and in this year's land preparation. Although the results of the first year are surprising, we still feel that the data is valid. The virus was detected from the inoculated areas in all assays, so we know environmental conditions for infection were suitable. It appears that irrigation does not move BNYVV as rapidly or as efficiently as was once believed.

The information obtained from this study should be useful for most sugar beet growing areas of the U.S. because growing conditions and cultural practices in Texas are representative of most growing regions other than California. This could also prove to be a very timely study because of the new reports of Rhizomania from Idaho, Wyoming and Nebraska in 1992.

USE OF PCR TECHNOLOGY FOR THE STUDY AND DETECTION OF BNYVV

C. M. Rush

The polymerase chain reaction (PCR) is a method in which extremely small quantities of DNA can be amplified or increased to detectable levels. Plant viruses are composed of RNA surrounded by a protein coat and, therefore, cannot be used directly in a PCR reaction. However, by using viral RNA as a template in a reverse transcriptase reaction complimentary DNA (cDNA) can be made and used in PCR. In this manner, a single virus particle can theoretically be detected. Because of the potential of PCR for specifically detecting extremely small quantities of virus in plant material, a study was initiated to evaluate the usefulness of PCR for detecting and studying BNYVV.

Materials and Methods

Primers were developed for all four RNAs of BNYVV using published nucleotide sequence data from a French isolate of BNYVV. One primer for first strand cDNA synthesis was common to all four RNAs, but all other primers were specific for a single RNA.

BNYVV was maintained on sugar beet grown in the greenhouse. A second furovirus of sugar beet designated Tx7 was also used in these studies. Virus was extracted from infected plants and used as a template in first strand cDNA synthesis in a reverse transcriptase reaction. cDNA specific for each RNA was synthesized and then used in PCR reactions. PCR products were loaded onto a 1.2% agarose gel for electrophoresis, stained with 0.5% ethydium bromide and visualized with an ultraviolet light. PCR products were also cut with various restriction enzymes to verify they were the expected products. Emphasis was placed on RNA1 in these studies.

Results and Discussion

The primers used in this study, which were based on published nucleotide sequence data from French isolates of BNYVV, were effective in detecting American isolates of BNYVV from California and Texas. All four RNAs of BNYVV could be detected with specific primer sets. PCR products for each RNA were of the expected size as determined by agarose gel electrophoreses. Primers specific for BNYVV RNA1 were also able to detect Tx7. However, instead of a PCR product of 1056 bases as with BNYVV, a slightly smaller product ≈ 950-1000 bases was produced. When cut with several restriction enzymes, the

fragments were of the size predicted for BNYVV. In some instances, restriction fragments from the Tx7 PCR product were closer to predicted sizes based on the nucleotide sequence of the French BNYVV isolate than the Texas BNYVV isolate. These results suggest that the 3' ends of RNA from Tx7 and BNYVV are very similar.

PARTIAL CHARACTERIZATION OF AN UNNAMED SOILBORNE SUGAR BEET VIRUS IN TEXAS

G. B. Heidel, C. M. Rush, T. L. Kendall and S. A. Lommell

An unnamed sugar beet virus, currently referred to as Texas 7, is a member of a suggested complex of soilborne sugar beet viruses associated with beet necrotic yellow vein virus (BNYVV). Texas 7 is similar in shape and size to BNYVV, but the two viruses differ serologically. Like BNYVV, Texas 7 is transmitted by *Polymyxa betae* Keskin. Foliar symptoms, when present, can include pale yellow vein banding that can progress to bright yellow, broad vein banding in older leaves. Leaves can be mottled or slightly distorted. Foliar symptoms associated with Texas 7 can be found without great difficulty in the field, while those caused by BNYVV are seen only rarely. Taproots of beets infected with Texas 7 often appear healthy, unlike those of beets infected with BNYVV. It has not been established if Texas 7 affects sugar beet yield or quality.

The objectives of this study are to determine some of the physical, biological and serological characteristics of Texas 7. Specifically, the goal of this work is to determine the number and size of Texas 7 RNAs, whether the RNA is polyadenylated, coat protein molecular weight, virus particle number and size, whether BNYVV and Texas 7 might be cross reacting serologically and the host range of Texas 7 by mechanical inoculation.

Materials and Methods

Virus purification. Texas 7 was purified by a method used to purify soilborne wheat mosaic virus, a bipartite virus transmitted by *Polymyxa graminis* Ledingham. The virus was increased in *Chenopodium quinoa*, a local lesion host of Texas 7. Briefly, infected *C. quinoa* leaf tissue was ground in liquid nitrogen and thawed in 4 volumes (w/v) 0.5 M borate buffer, pH 9, with 1 mM EDTA and 0.1% 2-mercaptoethanol (grinding buffer). After straining through cheesecloth, the extract was centrifuged at 7000 rpm in a Beckman JS-13 swinging bucket rotor at 4C for 20 min. The supernatant was strained through Miracloth, and Triton X-100 was added to a final concentration of 2%. The extract was underlayed with 20% sucrose (w/v) in grinding buffer and centrifuged 2.5 hr in a Beckman Type 42.1 rotor at 27,400 rpm at 4C. The pellet was resuspended in 0.05 M borate buffer, pH 8, with 1 mM EDTA. The virus preparation was subjected to a second series of low and high speed centrifugations, and the final pellet was resuspended in 0.05 M borate buffer, pH 8, with 1 mM EDTA.

RNA analysis. RNA was extracted from purified virus with chloroform and phenol and precipitated with ethanol. For estimation of the number and size of RNA species, the RNA was electrophoresed in a 1% agarose formaldehyde denaturing gel against a 0.24-9.5 kilobase (kb) RNA ladder. To determine if Texas 7 is polyadenylated, purified RNA was passed through an oligo (dT) cellulose column. Both the bound and unbound fractions were collected and electrophoresed in a nondenaturing agarose gel.

Coat protein analysis. Purified virus was denatured and electrophoresed in a polyacrylamide gel against a protein molecular weight ladder and BNYVV. A similar gel was run for Western blot analysis. For the Western blot, protein was transferred from the gel to nitrocellulose and probed with Texas 7 or BNYVV antiserum.

Electron microscopy. For immunospecific electron microscopy (ISEM), electron microscope grids were coated with BNYVV or Texas 7 antiserum and floated on *C. quinoa* leaf extracts from plants infected with Texas 7 or BNYVV. The number of particles bound to the grids in five different areas on each grid was counted. Particle lengths were estimated from the ISEM grids.

Host range. Approximately 30 plant species from 10 families were mechanically inoculated with extracts of *C. quinoa* leaf tissue infected with Texas 7. The plants were observed for symptom development. At the end of one month, or when symptoms developed, tissue was back-inoculated to *C. quinoa*.

Results and Discussion

Texas 7 appears to be composed of 3-4 polyadenylated RNAs surrounded by a coat protein with an estimated molecular weight of 24 kilodaltons (kDa). Four Texas 7 RNA bands were seen after electrophoresis in a denaturing gel. Their sizes were estimated at 6.6, 4.4, 1.2 and 1.0 kb. The reported sizes of BNYVV RNAs are 6.8, 4.7, 1.8, 1.5 and 1.45 kb. The molecular weights of Texas 7 RNAs 1 and 2 (6.6 and 4.7 kb, respectively) are close to the reported molecular weights of BNYVV RNA 1 and 2. Texas 7 RNAs 3 and 4 are both smaller than the smallest BNYVV RNA. The bound fraction of Texas 7 RNA, when it was eluted from the oligo (dT) cellulose column, separated into three distinct bands, with a possible fourth smaller band. The banding pattern was similar to what was seen in the denaturing gel.

Texas 7 coat protein molecular weight was estimated at 24 kDa. The reported molecular weight of BNYVV coat protein is 21 kDa. In this study, BNYVV coat protein molecular weight was estimated at 20.4 kDa. No serological cross reaction between BNYVV and Texas 7 was detected in Western blots.

Texas 7 seems to be a multiparticulate virus, made up of 3-4 particles. Seventy-eight Texas 7 virus particles were measured to determine length and length distribution. There was a wide range of length values, from about 30 nm up to 325 nm. Of the particles that were measured, 20% fell into the 45-55 nm range, 24% were between 70 and 125 nm, 28%

were between 175 and 225 nm, and 5% were between 290 and 325 nm. Modal values in these ranges were 50, 95, 100, 210 and 290 nm. Seventy-eight particles is a fairly small sampling, and more particle measurements should be taken to better determine particle number and length.

More particles were counted on electron microscope grids that were coated with antiserum homologous to the virus in the leaf extract (e.g., Texas 7 antiserum-coated grids floated on plant extract containing Texas 7 or BNYVV antiserum-coated grids floated on plant extract containing BNYVV) than on grids coated with the heterologous antiserum. A few particles were trapped by the heterologous antiserum, though, indicating possible serological relatedness between Texas 7 and BNYVV. However, to verify that the particles seen trapped on grids coated with heterologous antiserum were not trapped as a result of non-specific binding, further studies will be conducted using antiserum developed to a plant virus unrelated to either Texas 7 or BNYVV.

Host range determined to this point by mechanical inoculation is limited to the Chenopodiaceae. Symptoms vary in *C. quinoa*. Symptoms observed include bright or pale yellow local lesions or pale yellow local lesions with small areas of reddish or brown necrosis. *Beta maritima* develops faint yellowing, systemic mottling and some distortion. Faint yellowing develops in spinach. In *Beta macrocarpa*, yellow local lesions usually develop, sometimes followed by systemic mottling.

Based on these results, Texas 7, a member of the furovirus group (fungally-transmitted rod-shaped viruses), is closely related to BNYVV. BNYVV is the only member of the furovirus group with more than two particles and polyadenylated RNA. Texas 7 is similar to BNYVV in particle morphology and particle number, and its RNA is also polyadenylated. Texas 7 is serologically different from BNYVV, but the possibility of some serological relatedness between Texas 7 and BNYVV cannot be ruled out. Although these two viruses are related, as far as both belonging to the furovirus group, whether they are strains of the same virus or are two distinct viruses within the same group has yet to be established, and will require additional testing.

Laboratory Rearing of Sugar beet Root Aphids, *Pemphigus betae* Doane, Notes, Applications, and Future Avenues of Research

A Report of Research Sponsored by the
Beet Sugar Development Foundation, 1992

Project 520

by

G. J. Michels, Jr., B. J. Thompson, and R. L. Whitaker-Deerberg
Texas Agricultural Experiment Station
Texas A&M University System
6500 Amarillo Blvd. West
Amarillo, Texas 79106

Following the results of the research conducted in 1991(Michels et al. 1991), we investigated the feasibility of the methods we developed to produce large numbers of sugar beet root aphids in the laboratory. We are also including insights and notes on the technique that will be of interest to other researchers.

Experimental Techniques and Notes. As of this report, we have a good technique for rearing large numbers of sugar beet root aphids in the laboratory. It has been quite common to keep up to 20 rearing plates active for up to two months with 50 to 300 aphids per plate. The rearing media consists of approximately 400 g of autoclaved soil placed in sterilized petri dishes with an intact, approximately three-month old sugar beet.

It is very important to ensure a clean environment for the rearing plates since contamination almost always causes the growth of unwanted fungi that ruin the colony in a short time. The type of soil used in the rearing plate does not seem to influence the aphids to any great extent. We have used both a commercial potting soil and a Pullman clay loam soil from a nearby field with equal success. We have noted, however, that the beets used in the plates produce new roots more quickly in potting soil than in the Pullman clay loam. This may be directly related to the fertility of the soil.

The whole sugar beet is used for two reasons. First, in previous attempts, cut beets or beet sections deteriorated rapidly and fungal growth was almost unavoidable. Second, the whole beet seems to provide a much better substrate for the aphids than a section of the beet. The two reasons are probably interrelated.

The best temperature for producing large numbers of aphids seems to be 25-27°C. Beets kept at 20-22°C took at least a month longer to produce the same number of aphids. The colonies should also be kept in total darkness. Although exposing the colonies to light during sampling times does not have an effect, long exposures to light causes the production of winged adults. This may not be a concern if winged adults are the sought after product, but nearly total darkness is needed to keep a colony intact for a long period of time.

Good colonies can be initiated with as few as two aphids in a rearing plate, and can go as high as 50. Unusually large numbers of aphids placed into a rearing plate will not survive very long, probably due to competition.

We have noticed that the aphids tend to stay with the beet as long as the beet tissue is of good quality. Once the beet begins to discolor, the aphids begin to move around, eventually coming to the top of the rearing plate in large numbers. If the aphids are transferred at this point, new colonies can be started without a problem. Permitting the colony to remain in the rearing plate with a discolored, necrotic beet will cause the colony to die out rapidly. A curious aside to this point in the life of the colony is that if a beet is just about to die, the adults in the colony begin to rapidly produce nymphs in large numbers. After a few days, large numbers of nymphs can be found crawling all around the rearing plate but no live adults will be found. In this case, the adults, reaching the end of their life span on a deteriorating host, probably produce as many nymphs as possible in order to ensure species survival. This type of reproductive behavior is noted quite often with aphids. A case in point would be the greenbug, which will show a flush of reproduction following an insecticidal application.

Applications. An application of the aphid behavior noted when the beets begin to die may be of particular importance when screening candidate varieties in the laboratory for sugar beet root aphid resistance. All three resistance modes (i.e. tolerance, antibiosis and antixenosis) should be able to be discriminated. A researcher should be able to clearly tell when the candidate varieties have become damaged by the aphids to the point that they are beginning to die by observing the aphids' movement to the top of the rearing plate and the potential reproductive flush of new nymphs.

If tolerance to the aphid is noted in a particular variety, the movement of the aphids out of the soil and to the top of the rearing plate should come after a significantly longer time than on a susceptible variety.

Theoretically, if a particular variety exhibits antibiotic properties, the reproductive flush of new nymphs should be significantly less than that observed on a susceptible variety. At the present time, this is a tenuous hypothesis, but will be investigated more thoroughly in the future. The primary supposition here is that the adults reared on antibiotic varieties would be significantly less fit than those reared on susceptible varieties. Therefore, when the beets became unsuitable hosts, these adults would not be able to produce as many young as those aphids reared on preferred hosts.

Antixenosis (non preference) could be ascertained by noting aphid colonies that never settle well on a particular variety when compared with a susceptible variety. This type of test could either be run in separate rearing plates, where the relative condition of the aphids is noted, or beets from both a susceptible and an expectedly antixenotic variety could be placed in the same rearing plate. Aphids should congregate on the susceptible variety rather than the antixenotic variety, although care would have to be taken to ensure that the experiment is evaluated prior to the susceptible variety being damaged to the point that the aphids move to the candidate variety.

Current Status and Future Considerations. In 1992 we started experiments to determine the growth and development of individual nymphs. This proved to be an extremely difficult process. With the media we are using, it is nearly impossible to determine the development of an individual aphid through time due to the inability to find cast nymphal skins, and in some cases, the individual aphid itself on a day-to-day basis. There is no problem finding aphids if the experiment is being terminated, but to find, record and replace an individual aphid on a daily basis leads to high mortality in

most cases. Of 12 separate experiments we conducted to observe individual aphid development, one survived. This is much too time consuming to pursue in the future in its present form. We will pursue different methods to isolate individual nymphs in order to perform this research. At the current time, as an alternative measure, we are going to determine the sugar beet root aphid's mass density increase over time. This will consist of placing known numbers of nymphs in clean rearing plates, allowing them to develop and reproduce for a given period of time, and then harvest the whole plate to determine the colony growth potential over time rather than the growth and development of individual aphids. This research will be done over a range of temperatures from 10 of 35°C. In 1993, we will also examine the validity of the laboratory rearing techniques and its associated observations on varieties ranging in susceptibility to the sugar beet root aphid.

NATIONAL AGRICULTURAL LIBRARY
1022882667